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Shewing how their Properties may be aſcertained, their Virtues
preſerved, their Impurities corrected, &c.

WITH AN

APPENDIX ON THE MEPHITIC-ALKALINE WATER;

A NEW AND APPROVED
REMEDY AGAINST THE STONE AND GRAVEL.

By A. FOTHERGILL, M. D. F. R. S.
Member of the Royal College of Physicians,
and of the Medical Societies of
London, Edinburgh, and Paris.

Intrandum eſt in rerum naturam, & penitùs quid ea poſtulat, pervidendum.
Cic.

BATH:
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TO

THE REV. JAMES STONHOUSE, M. D.

RECTOR OF GREAT AND LITTLE CHEVEREL, WILTS;

AND FORMERLY PHYSICIAN TO THE NORTHAMPTON INFIRMARY:

WHOSE SKILL AND HUMANITY AS A PHYSICIAN,

WHOSE ZEAL AND ELOQUENCE AS A PREACHER,

AND WHOSE EXEMPLARY CONDUCT AS A DIVINE,

HAVE CONSPIRED TO RENDER HIM AN ORNAMENT TO BOTH PROFESSIONS;

AND, WHAT IS YET MORE IMPORTANT,

THE FRIEND, AND BENEFACTOR OF MANKIND:

THE FOLLOWING INQUIRY,

AS A SINCERE, THOUGH INCONSIDERABLE TRIBUTE OF

GRATITUDE, *AFFECTION*, AND *ESTEEM*,

IS MOST RESPECTFULLY INSCRIBED,

BY HIS MOST OBLIGED FRIEND,

AND VERY HUMBLE SERVANT,

THE AUTHOR.

PREFACE.

AS an acknowledgment for the very favourable reception which the former impreſſion met with, the PUBLIC is here preſented with the following IMPROVED EDITION. In order to render this more worthy their acceptance, the former (which had been long out of print, though repeatedly called for) has been reviſed throughout, and many of the experiments repeated.

As a further teſtimony of his reſpect, the Author now ſubmits to their conſideration ſome additional obſervations on OTHER WATERS, which (if he may be permitted to judge from the importance of the ſubject) will not be found wholly unworthy their attention.

COMMON WATER, being the baſis or foundation of all the waters of our globe, was judged worthy to take the lead. The various impregnations, of which it occaſionally partakes, naturally led to the conſideration of the waters of the Ocean, and Mineral Springs. As theſe, at preſent, adminiſter ſo conſpicuouſly to our health, convenience, and amuſement, and are even thought worthy to conſtitute our moſt faſhionable remedies, they could not, with any propriety, be paſſed over in ſilence.

The *Analyſis of Waters* has always been deemed an object of importance, and, when it comes to be more cultivated, will doubtleſs be conſidered, by perſons of a liberal education, as a branch of ſcience not leſs uſeful than entertaining.

Philoſophical chemiſtry, the foundation of this and almoſt every other uſeful ſcience, has of late years received innumerable improvements, and is now rapidly advancing towards perfection, not only in England, but alſo in Germany, France, and Italy. To many of whoſe diſtinguiſhed authors we are indebted for great and important diſcoveries, which cannot fail to immortalize their memories.

Among thoſe of our own country, is it neceſſary to mention the names of BLACK, CULLEN, PRIESTLEY, CAVENDISH, KIRWAN, &c.? or abroad, need we enumerate thoſe of BERGMAN, SHEELE, LAVOISIER, BERTHOLLET, ACHARD, &c.? Their ingenious publications are far beyond my praiſe, but will ſpeak their own eulogy to all ſucceeding generations. To all of them, I acknowledge my obligations, for the pleaſure and inſtruction which their writings have afforded me. To the incomparable **Bergman** *firſt*, is the tribute of gratitude particularly due—and *next*, to ſome of our own illuſtrious countrymen.

Authors who formerly favoured the world with their Analyſes of Mineral Waters, collected their ſolid contents with conſiderable exactneſs, and from thence *alone* they deduced their real or imaginary virtues. But they wholly neglected the volatile aërial parts which were ſuffered to eſcape during the proceſs, though theſe confeſſedly conſtitute the moſt active ingredients in the compoſition.

Much however is due to their labour and induſtry, and even their errors claim our indulgence, conſidering the ſlow progreſs of ſcience, when unenlightened by the rays of chemiſtry. It ſeems to have been reſerved for the preſent age, to develope the myſtery concerning the **Mineral Spirit** of Waters, formerly conſidered as altogether *inſcrutable*; and alſo to demonſtrate, that many of the ſubſtances, which have appeared to be ſimple, are in reality compounds.

In a word:—The valuable diſcoveries concerning *aërial fluids*, and particularly fixed air, (which uniting with other bodies forms new compounds, poſſeſſed of their own peculiar properties) have already produced ſo conſiderable a revolution in former ſyſtems, as to conſtitute a new and important æra. As thoſe lead to a more accurate knowledge of the conſtituent parts of natural bodies, ſo they cannot but materially influence the doctrine of Mineral Waters.

The increaſing reputation of the CHELTENHAM SPA had indeed long attracted public attention, but ſurely its ſalubrious powers were never before exerted in ſo NOBLE a cauſe as that of the HEALTH of its SOVEREIGN. An attempt, therefore, towards an *improved Analyſis* of the WATERS will not, it is hoped, at *this juncture* be thought UNSEASONABLE.

The following experiments, though chiefly intended as the amuſement of a few leiſure hours, were nevertheleſs carefully conducted, and the phenomena minuted down as they occurred, though without deſcending to unneceſſary minuteneſs. A paper, containing the reſult, was afterwards communicated to ſome able judges, who deemed it not unworthy publication; otherwiſe, perhaps, it never would have ventured to have met the public eye.

Its Author, having no intereſt to ſerve either in depreciating the water, or exaggerating its virtues—no particular theory to ſupport—nor any object in view—except that of truth, has often indeed been obliged to controvert certain doctrines which had hitherto been implicitly received as ſacred oracles.

In attempting, however, to point out the errors of others, he is by no means forgetful of his own; but ſhall, at all times, be ready to rectify any overſight that may have eſcaped him in the following pages.

Conſcious of the difficulty of the undertaking, and the fallacy to which experiments of this nature are liable, he claims further indulgence to render the preſent analyſis complete. If, in the interim, it ſhould tend but to advance the knowledge of waters in *general*, or contribute in any degree towards a more rational and ſucceſsful uſe of this water in *particular*, his principal aim is accompliſhed, and his time fully compenſated.

❧

CONTENTS.

CONTENTS.

Page.

PREFACE—containing ſome Account of the additional Articles in the preſent Edition—Improvements in Chemical Knowledge—transferred to the Analyſis of Waters—applied to that of Cheltenham vi

Water—whether an Element 1

—— its Properties—Habitudes 7

—— different Impregnations 11

Mineral Waters 14

—— their Contents—Hot Springs—whence 15

Analyſis of Waters—its Importance 19

Senſible Qualities of Waters firſt to be obſerved—next by Chemical Teſts 21

—— by Evaporation—Cryſtallization 27

Criterion of the Analyſis 28

Sea-Water—how rendered freſh 31

—— its Contents—why different at different Depths 34

Hard Waters what—how corrected 37

Stagnant Waters how purified 41

The Filtering Stone when uſeful 43

Cheltenham,

Cheltenham, its Situation — — 45
Improvements—Royal Viſitors — 47
Cheltenham Water—Senſible Qualities—Temperature —Specific Gravity — — 48
Habitudes with Precipitants — 49
Volatile Parts, how obtained — 51
Solid Contents obtained by Evaporation — 52
Properties of its Salts — 53
Of its Dry Reſiduum — — 56
—— *volatile Parts when loſt whether recoverable* 57
—— *Inferences from the Analyſis* — 58
—— *Its Purging Salts—their Nature how diſtinguiſhed* — — 65
—— *Its ſolid Contents—their Nature* — 68
—— *Its Mineral Spirit—how preſerved—or reſtored when loſt* — — 70
Cauſe of Decompoſition in Bottles hermetically ſealed 72
—— *Solid Contents in a Gallon* — 73
—— *Aërial Fluids in like quantity* — 74
—— *The medicinal Properties of each* — 77
Fixed Air—how diſtinguiſhed from volatile Vitriolic Acid—its Energy in Mineral Waters — 83
Hepatic Air—gives Sulphureous Quality — 84
Cheltenham Water unfriendly to Vegetation—is diuretic or diaphoretic, according to Circumſtances 85
—— *Its Operation in Diſeaſes of the Firſt Paſſages —in thoſe of the Lymphatic Syſtem* — 86
—— *whether explicable on Mechanical Principles* 98

——— *Three Claſſes of Diſeaſes to which it is adapted* 90
——— *wherein doubtful* — — 92
——— *Whether in Tubercles of the Lungs* 93
——— *wherein improper* — — 94
Directions for drinking the Water — 95
Diet and Regimen adapted thereto — 101
What Circumſtances to be avoided — 102
Analyſis of other Mineral Waters recommended—Advantages that would thence reſult — 103

APPENDIX.

Water, whether eſſential to Air — 107
——— *whether capable of Decompoſition—whether its component Parts be yet known* — 108
Cheltenham Water, how imitated by Art — 109
Mephitic Alkaline Water—its Antiſeptic Quality 111
——— *its Efficacy againſt Stone and Gravel* 112
——— *how beſt prepared* — 113
——— *whether it be not Diuretic* — 119
——— *a Deception concerning Soap Ley explained* 120
——— *the Calculus—its Component Principles, and whether it can be decompoſed* — — 121

Quæ huic opuſculo deſunt, ſuppleat ætas.

QUINTIL.

A NEW EXPERIMENTAL INQUIRY, &c.

WATER,

Whether an Element—Its general Properties—and Habitudes with other Bodies.

WATER, when perfectly pure, is a ſimple fluid deſtitute of odour, taſte, and colour. It enters the compoſition of all bodies, whether animal, vegetable, or mineral, except metals, and ſiliceous earths, and may be again obtained from them by diſtillation. Till lately, it has been allowed by philoſophers to be one of the FOUR ELEMENTS; nay, ſome of them have gone ſo far as to maintain water *alone* to be the elementary matter, out of which, all things in the viſible creation are formed, and into which, by chemiſtry, they may be re-converted.

From the experiments, however, of ſome of the moſt ingenious philoſophers of the preſent day, it would appear that water is no longer to be conſidered as a ſimple element, but a compound body, conſiſting of a certain portion of vital and inflammable air.*—"That it is produced, not only by "the exploſion of theſe two airs by the electrical "ſpark, but alſo by reviving mercury from red pre-"cipitate in alkaline air. In this inſtance, ſay they, "the precipitate ſupplies the vital, or dephlogiſti-"cated air; and the alkaline air, the phlogiſton." But is it not ſingular then, that no water is produced by reviving mercury from red precipitate?

Water, I conceive to be eſſential to the formation of inflammable air, becauſe the latter cannot be produced from a ſolution of iron in the vitriolic acid, unleſs the acid be firſt conſiderably diluted with water. Now, admitting this, may not the water ſeemingly obtained from the combination of the two airs, proceed from a precipitation of that fluid from the inflammable air? or, in other words, may not the water thus procured be conſidered rather as a natural conſequence of the *decompoſition* of inflammable air, than a *real production* of water? In this light, it may not be amiſs for the preſent to view this curious phenomenon, till the new doctrine be more fully illuſtrated by future experiments, though other arguments are not wanting which ſeem to prove water a real compound.

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* See Cavendiſh's Experiments, Philoſophical Tranſactions, vol. lxxiv. art. 13. Alſo M. Lavoiſier's Obſerv. ſur la Phyſique, tom. 23, p. 452.

Not only water, but even pure air, fire, and earth, have been pronounced, by modern chemiſts, COMPOUND BODIES. If this be true, the ANCIENT ELEMENTS no longer exiſt, and we may ſoon expect to ſee the famous *Berkleian* ſyſtem re-eſtabliſhed. When this happy period arrives, how pleaſant will it be to behold its *ideal* ſupporters contemplating *ideal* bodies, amidſt numerous *ideal* worlds—of their own creation! The phlogiſton too has lately ſhared the ſame fate. This ſubtile principle, which was wont to be conſidered as one of the moſt powerful agents in nature, is now declared, by ſome of the Royal Academicians at Paris, to have no real exiſtence. Though they have hitherto failed of entirely convincing us of its nonentity, they have neverthelefs diſplayed no ſmall ſhare of ingenuity, and adroitneſs in explaining *away* this fugitive principle, and even in accounting for all the phenomena, without its aid.

Water is a *ſolid* body when Farenheit's thermometer ſtands below 32°; and *fluid*, when the mercury riſes above that point, as it more frequently does, in all temperate climates; hence water, by European philoſophers, is defined a *fluid*. But whether fluidity be its *natural* ſtate, or the effect of *violence*, may admit of controverſy. For whenever the degree of heat neceſſary to keep it in fuſion, is abſent, it inſtantly aſſumes a hard cryſtalline form, under the denomination of ice.

Though ice is commonly reputed *water* brought into a preternatural ſtate by cold, yet with regard to the real nature of things, and ſetting aſide our arbitrary ideas, it might as juſtly be ſaid, that water is *ice* preternaturally thawed by heat.

The cryſtalline appearance of water, in form of ice, doubtleſs led Sir Isaac Newton into the miſtake of water being a real ſalt, without reflecting that it is not only deſtitute of the diſtinguiſhing marks of that claſs of bodies, but acts as their univerſal ſolvent, which it never could do were itſelf a ſalt. Beſides, it not only diſſolves gums, gelatinous ſubſtances, ſaponaceous matters, common air, and gas, but alſo unites readily with alcohol, and in a certain proportion even with æther and eſſential oils; properties inconſiſtent with thoſe of any ſalt yet diſcovered. On perfect metals it has no effect, though it corrodes ſome other metallic ſubſtances in contact with the air. Is this occaſioned by the aerial acid? Or is it not rather owing to the vital air of the atmoſphere ſubtracting the phlogiſton of the metal?

Water is a volatile body, and alſo ſoluble in air, as ſalt is in water, and hence it riſes in the atmoſphere in form of miſt, or vapour; when condenſed it again deſcends in rain, hail, or ſnow, according to the temperature it meets with in the upper regions; but then it ſoon returns to its original ſtate of water, without appearing to have undergone any ſenſible change.

At 112 degrees of heat, it boils, and aſſumes a highly elaſtic form, and is then incapable of any greater degree of heat in open veſſels, though, confined in a perfectly cloſe veſſel, it may be rendered red hot. But in this proceſs, as well as in fermentation, wherein it ſucceſſively paſſes from a ſtate of water to that of wine, and alcohol, and from thence to vinegar, it probably undergoes a remarkable *decompoſition*; and if ſo, it confirms the idea of its being a compound: otherwiſe theſe wonderful changes, it is preſumed, can never be ſatisfactorily explained, and the myſtery of fermentation muſt ever remain altogether incomprehenſible.

Water is the moſt ſubtile and penetrating of all bodies, fire *only* perhaps excepted. It eaſily pervades ſubſtances which are impervious to air, nay, it is ſaid to be capable of being forced even through the pores of gold, ſo that the moſt ſolid bodies in nature, under certain circumſtances, are found permeable to water. Whatſoever therefore may be its conſtituent parts, if water be really a compound, they muſt be *inconceivably* minute.

Water, conſidered by itſelf, and free from any heterogeneous mixture, is probably always of the ſame nature; but during its paſſage through various *ſtrata*, it becomes impregnated with various ſubſtances, partly ſuſpended in it, and partly united with it by chemical ſolution; hence no water is ever found upon the ſurface of the earth in a ſtate of perfect purity. Nay, even rain, and ſnow water, though elaborated by the peculiar powers of nature from the moſt ſubtile vapours, with a degree of perfection inimitable by art, are nevertheleſs found variouſly contaminated, according to the ſtate of the atmoſphere and other circumſtances.

The pureſt of all waters we can arrive at, is that diſtilled from ſnow carefully collected in ſome very high ſituation. By repeated diſtillations, the greateſt part of the earth and other fæculencies may be ſeparated from this, and this is what we muſt be contented to call *pure* water.

The ſpecific gravity of pure water has been generally eſtimated at 850 times as heavy as air. But it is difficult to fix its ſpecific gravity, in order to aſcertain its degree of purity, becauſe it ſeldom continues many minutes exactly of the ſame weight, by reaſon of the air and fire contained therein. Thus a piece of pure ice placed in a nice balance, never continues two moments in equilibrio. But this we may ſay in general, that pure water, according to the lateſt and moſt accurate experiments (the thermometer being at 50°, the barometer at $29\frac{3}{4}$) appeared to be only about 800 times as heavy as air.

Water perfectly diſſolves all ſaline bodies, and even glaſs itſelf, when previouſly fuſed with an alkaline ſalt.

The quantities of ſaline ſubſtances that could be diſſolved in a ſingle ounce of pure water, with the heat of 50° of Farenheit's thermometer, were as follows:

	Grains.
Regenerated Tartar — —	470
Epſom Salt — — —	324
Salt of Tartar — — —	240
White Vitriol — — —	210
Sal Gem — — — —	200
Salt of Soda, or marine alkali —	200
Sal. Ammoniac — — —	176
Marine Salt — — —	170
Salt of Glauber — — —	160
Vitriol of Copper — —	124
Vitriol of Iron — — —	80
Salt of Nitre — — —	60

Vitriolated

	Grains.
Vitriolated Tartar — —	60
Sublimate Mercury — —	30
Borax — — — —	20
Alum — — — —	14
Salt of Amber — — —	5
Arſenic — — — —	1
Cream of Tartar — —	3

Selenite, or Gypſum, requires at leaſt 500 times its weight of water to diſſolve it. Barytes, or *Terra ponderoſa*, 900.

Though water is only capable of holding in ſolution a certain quantity of any given ſalt, to the point of ſaturation, yet the water eſſential to cryſtalization enables it afterwards to diſſolve an additional quantity of other ſalts in ſucceſſion, to a very large amount.

Thus four ounces of water already ſaturated with nitre, will diſſolve of white vitriol, half an ounce; of common ſalt, 6 drams; of ſal. ammoniac, 6 drams; of ſoluble tartar, half an ounce; and after all theſe, an entire ounce of ſugar.—A curious phenomenon in chemiſtry! worthy the attention of the Philoſopher, and particularly intereſting to thoſe who are concerned in pharmaceutical operations.

The uſes of water are extremely important to mankind, in food, in medicine, and in divers arts and manufactures.

As a food, it appears, from many inſtances, that water alone is capable of ſuſtaining human life a much longer time than could be well imagined. Water, as a common beverage with all kinds of aliment, affords the beſt and moſt univerſal diluent in the world. For this purpoſe, that which is pureſt, lighteſt, ſofteſt, and moſt tranſparent, is undoubtedly the beſt.

" As to the medicinal powers of pure water (ſays " an eminent writer*) that ſimple fluidity, the abſence of every quality that can offend the tendereſt " organ, miſcibility with the animal juices, diſpo- " ſition to paſs off by the cutaneous pores more " plentifully than by the kidnies, in conſequence " of its total want of irritation, conſtitute the prin- " cipal part of its medical character.

To which we may add, that it is the moſt commodious medium for applying to the human body the powerful agents heat and cold; of which the one expands and relaxes, the other contracts, and conſtringes all the ſolid parts of the animal machine.

---

* The late Dr. Lewis.

The learned **Hoffman**, and other reſpectable authors, have eſteemed water almoſt an univerſal remedy. And it muſt be confeſſed, that in many acute diſeaſes, where the intention is to extinguiſh febrile heat, cold water, in conjunction with cool air, far ſurpaſſes not only the noted Fever Powders, but other febrifuge *noſtrums*, and when properly applied, and duly adminiſtered, probably ſtands unrivalled.

Convinced of this by long experience, the Italian Phyſicians ſcruple not to adminiſter water made cold by ice, to the amount of 12 or 15 pints in a day, applying at the ſame time, cold water or ſnow, to ſeveral parts of the body. By this method, as appears from their writings, they have upwards of fifty years paſt, been in the habit of treating fevers, even the *ſmall-pox*, and that with a ſurpriſing degree of ſucceſs.* Whence it is evident they have long anticipated the boaſted improvements of our modern inoculators, and have alſo carried the antiphlogiſtic regimen to a much greater extent, even making all poſſible allowance for the difference between their climate and our own.

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* See Commerc. Norimb. 1736. Hebd. 8. ſect 2.

Different

The different Matters with which Waters are generally impregnated.

The various ſubſtances which occaſionally are are found united with water, and with each other, by diffuſion, or by chemical ſolution, may be chiefly comprized under four claſſes, viz. The Aërial, Saline, Metallic, and Earthy.

The Aërial, are
- Atmoſpheric air
- Vital Air
- Fixed Air
- Inflammable Air
- Hepatic Air
- Phlogiſticated Air.

The Saline, are
- Vitriolic Acid
- Nitrous Acid
- Marine Acid
- Vegetable Alkali
- Mineral Alkali
- Volatile Alkali
- Hepar Sulphuris.

The Metallic, are
- Iron
- Copper
- Mangeneſe
- Arſenic.

The Earthy, are
- Magneſia
- Pure calcareous Earth, or Lime
- Argillaceous Earth
- Barytes, or ponderous Earth
- Siliceous Earth.

From their combinations ariſe ſeveral compounds, or neutral ſalts, ſoluble in water. All thoſe that have been yet diſcovered, it is preſumed, are comprehended under the following heads:

Neutral Salts.

I. Vitriolic.

Vit. Acid with Mineral Alkali, yields Glauber's Salt
———— Vegetable Alkali—Vitriolated Tartar
———— Calcareous Earth—Selenite
———— Magneſia—Epſom Salt
———— Argillaceous Earth—Alum
———— Iron—Green Vitriol
———— Copper—Blue Vitriol
———— Zinc—White Vitriol.

II. Nitrous.

Nit. Acid with Mineral Alkali—Cubic Nitre
———— Vegetable Alkali—Common Nitre
———— Calcareous Earth—Calcareous Nitre
———— Magneſia—Nitrated Magneſia.

III. Marine.

III. MARINE.

Marine Acid with Mineral Alkali—Common Salt
———————— Vegetable Alkali—Digeſtive Salt
———————— Calcareous Earth—Salited Lime
———————— Magneſia—Salited Magneſia.

IV. AERIAL.

Aërial Acid with Mineral Alkali
———————— Vegetable Alkali
———————— Pure Calcareous Earth or Lime
———————— Pure Magneſia
———————— Iron*
———————— Zinc
———————— Manganeſe. All which afford Aërated Compounds, more or leſs ſoluble in water, and therefore partaking of the nature of neutral ſalts.

Beſides theſe, ſometimes are found ſulphur, foſſil oil, and extracts from vegetable and animal ſubſtances. The foregoing heterogeneous matters are never found all together, but are more or leſs numerous in different waters.

Snow Water, though deſtitute of air, contains a minute portion of nitrous acid, and ſalited calcareous earth.

* Iron is ſometimes ſuſpended in waters by hepatic air:

Rain Water, beſides the above impregnation, contains a variety of heterogeneous matters, which float in the atmoſphere, and therefore never can be obtained pure, except after long-continued rain or ſnow, or on the tops of mountains remote from cities.

Spring Water. The waters of ſprings, wells, rivers, lakes, and marſhes, contain more or leſs atmoſpheric and fixed air, foſſil alkali, calcareous or argillaceous earths, combined with the aërial, vitriolic, nitrous, or marine acid; together with animal, or vegetable mucilage.

Next to ſnow water, the waters of certain ſprings and rivers, which flow rapidly over ſmooth pebbles, or bright ſand, are the pureſt, and conſequently beſt for internal uſe; thoſe of marſhes the leaſt ſo.

Mineral Waters.

Mineral Waters are impregnated with ſaline, metallic, or other matters already mentioned, in quantity ſufficient to affect the taſte, and to exert medicinal powers different from thoſe of common water. Some medicinal ſprings are hot, but the far greater number cold, or nearly of the ſame temperature with common ſprings ſimilarly expoſed.

The hot ſprings may probably derive their heat from ſubterraneous fire, as ſometimes actually happens in the neighbourhood of volcanos, but perhaps much oftener from the decompoſition of martial pyrites, or other ſulphureous ores brought into *contact* with *vital air*. Foſſil coal, and a variety of mineral ſubſtances, afford a conſtant ſupply of inflammable air in the bowels of the earth, but no *ſenſible* heat is produced, till *pure* air is admitted from the atmoſphere. This, preferring the inflammable principle to every other body, ruſhes into union with it, when *actual* heat is inſtantly generated; proceeding, according to circumſtances, in form of a ſmothering heat, a ſlow lambent flame, or burſting out into violent combuſtion, accompanied with tremendous exploſions.

Thus, it is eaſy to conceive, how huge beds of earth and mineral ſtrata may be kept continually hot, and conſtantly communicating their heat, together with their mineral effluvia, to the water, as it oozes through their pores, or flows through their ſubterraneous channels. Admitting the cauſe juſt aſſigned to be adequate to the effect, and conſonant to the laws of nature, may it not aſſiſt us in adjuſting the famous controverſy ſo long agitated among philoſophers, concerning the origin of hot ſprings; and at the ſame time reflect conſiderable light on the no leſs myſterious nature of volcanos and earthquakes?

Next, it may not be improper to attempt ſome explanation of the ingredients with which medicinal waters are generally impregnated, and the combinations which they form in conſequence of mutual attraction.

Aerial Fluids, generally abound both in hot and cold mineral waters, partly combined with the water, and partly with alkalis, earths, or metallic ſubſtances.

Acids, are ſometimes diſcoverable in an uncombined ſtate, but moſt frequently united to alkalis, earths, or metals.

Alkalis, are ſometimes found diſengaged, but generally in union with the aërial or other acids.

Lime, and **Magnesia**, frequently occur, combined with the aërial, the vitriolic, nitrous, or marine acid.

Terra Ponderosa, and **Manganese**, are ſometimes accidentally found united with marine acid.

Argillaceous Earth, or Clay, is ſometimes found in union with vitriolic acid, in form of alum; it has lately been diſcovered in the Nevil Holt water, joined to the marine acid, in form of ſalited clay.—A rare inſtance.

Iron, of all the metals, is moſt frequently diſcovered in mineral waters, and is held in ſolution commonly by the aërial or vitriolic acid;—ſometimes, perhaps, by the marine.

Copper, has only been found with the vitriolic, in form of blue vitriol.

Arsenic, being extremely difficult of ſolution, has, fortunately for mankind, very rarely, if ever, been found in mineral waters. How far the poiſonous effects of the celebrated Lake Aſphaltites may juſtify the opinion, I ſhall not preſume to determine; but certainly neither brimſtone, nor bitumen, with which it is ſuppoſed ſtrongly impregnated, can render it ſo deleterious; and were arſenic preſent in the water, the ſulphur would ſtrongly counteract its poiſonous effects, by changing it into orpiment.

Sulphur is diſcovered in certain mineral waters generally in form of hepatic gas or air; ſometimes diſſolved, by its union with alkali, or lime. In this ſtate it may poſſibly exiſt in form of genuine hepar, as in the noted ſulphureous water of Aix-la-Chapelle, and other hot ſprings, where real ſulphur has been found ſublimed, and adhering to the ſurrounding walls.

Analyſis of Waters.

When we conſider the variety of foreign matters with which even our common ſprings are impregnated, and that ſome of theſe matters, though ſmall in quantity, yet by being daily accumulated in the ſyſtem, may at length prove the unſuſpected cauſe of obſtinate chronic diſeaſes; it certainly concerns us to inquire diligently into the nature of the fluid which neceſſarily conſtitutes ſo conſiderable a ſhare of our daily ſuſtenance. More forcibly ſtill ought this caution to ſtrike us, when applied to medicinal waters, more ſtrongly impregnated, and abounding with far more active principles.

" An accurate analyſis of waters, (ſays the in-" comparable BERGMAN) is juſtly conſidered as one " of the moſt difficult problems in chemiſtry; never-" theleſs it is highly neceſſary, not only as an en-" tertaining branch of natural philoſophy, but as " ſubſervient both to public and private advantage." From thence we are enabled, *1ſt.* To chooſe the pureſt common water for internal uſe.

2d. To avoid ſuch as is either unfit or noxious.

3d. To form a proper judgment concerning medicinal waters. Thus, if long experience has ſhewn the efficacy of a certain ſpring, the contents of which are well known, we may inſtantly form a judgment concerning others whoſe contents exactly reſemble it, and thence be enabled to anticipate the experience of years.

4th. To ſelect ſuch waters as are beſt adapted to the ſeveral arts and manufactures, without which they never can be carried on with advantage.

5th. To correct impure or vitiated water, or to ſeparate from it extraneous ſubſtances, with which it is contaminated, or rendered pernicious.

6th. To imitate ſuch waters as are juſtly celebrated for extraordinary virtues, if a ſufficient quantity of the natural water cannot be conveniently obtained.

Senſible Qualities to be obſerved.

Previous to the chemical examination, the ſenſible qualities of the water ought to be carefully attended to. Such are the taſte, ſmell, colour, and

degree

degree of tranſparency. Theſe, together with its ſpecific gravity, temperature, and nature of the ſurrounding ſoil, to a nice obſerver, will afford conſiderable information.

Thus with reſpect to *Taſte*, the aërial acid gives a gentle ſmartneſs or poignancy;—vitriolic or nitrous ſalts, a bitterneſs;—lime or ſelenite, a ſlight auſterity;—alum, a ſweetiſh aſtringency;—mineral alkali, and marine ſalt, a nauſeous brackiſhneſs;—copper, a ſlight taſte of braſs;—iron, an inky taſte.

As to *Smell*, aërial acid diffuſes an agreeable penetrating odour like that of fermenting liquors;—hepatic air, an odour like that of a foul gun, or ignited gunpowder;—ſtagnant and corrupted waters emit a putrid offenſive ſmell.

Reſpecting *Colour*. Though good water is entirely without colour, yet colourleſs water is not always good. A brown, reddiſh, or yellow colour, betrays ſeveral animal, vegetable, or mineral impurities;—a blue indicates vitriol of copper;—a green, or variegated film, vitriol of iron;—and a yellow ochrey ſediment, puts this matter beyond a doubt.

Tranſparency. A cryſtal clearneſs indicates great purity, though very hard waters ſometimes aſſume this appearance. When the bottom is clay or mud, the water is never clear, but aſſumes a milkineſs or opacity which obſtructs the rays of light from paſſing through it.

Lightneſs, in the hydroſtatic balance, in general affords a favourable ſign of purity, eſpecially if there be found no earthy or ochry ſediment, no ſaline efflorescence in its neighbourhood, nor animalculæ in the water.

By Chemical Teſts or Precipitants.

The various impregnations are detected by certain chemical teſts, called *Precipitants.*

Aerial Fluids may be ſeparated, and collected by boiling the water in a glaſs retort with a long neck, bended upwards into the mouth of a receiver inverted in mercury, as deſcribed by Bergman.* If this apparatus be wanting, a ſimple Florence flaſk, with a bladder, may anſwer the ſame intention, if properly managed. The elaſtic fluid thus collected, conſiſts chiefly of a mixture of common air, and aërial acid.

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* See Chemical Eſſays, vol. i. p. 143, with a ſuitable drawing of the apparatus annexed.

To determine the quantity of each, one of them muſt be ſeparated.—This is performed by agitating the aërial fluids in a veſſel filled with lime-water. This will entirely abſorb the aërial acid, and leave the common air alone, the bulk of which ſubtracted from the whole, ſhews the quantity of aërial acid. The quantity and quality of the reſidue may afterwards be aſcertained.

COMMON AIR, and VITAL AIR, are diſtinguiſhed by ſupporting flame.

AERIAL ACID, and PHLOGISTICATED AIR,—by extinguiſhing flame, precipitating lime-water, and by changing the blue colour of litmus, red.

HEPATIC AIR, or SULPHUREOUS GAS,—by a fetid ſulphureous odour; by rendering white arſenic yellow, when immerſed in the water.

ACIDS,—by changing ſyrup of violets, and other vegetable blues, to a red colour.

ALKALIS,—by changing them to a green, and by precipitating a ſolution of ſalited lime in form of clouds, when dropt into the water; by changing tincture of Brazil wood *blue*; turmeric, *brown*; and ſolution of corroſive ſublimate, *yellow*.

VITRIOLIC SALTS,—as *Glauber*, *Epſom*, *Blue Vitriol*, *Green Vitriol*,—by a ſolution of *Terra Ponderoſa* in marine acid, otherwiſe termed *Barytes Salita*; a ſingle drop of which detects the ſmalleſt veſtige of *vitriolic acid*, in whichever of theſe forms it exiſts, by inſtantly producing white ſtreaks, or cloudineſs.

NITROUS SALTS,—as *Common Nitre*, and *Nitrated Lime*,—by *Solution of Silver in Nitrous Acid*, which dropt into the water produces a ſtriated whitiſh cloud:—By expoſing the reſiduum after evaporation to *ignited iron*, when a hiſſing or crackling noiſe will be perceived if nitre be preſent.

MARINE SALTS,—as *Common Salt*, *Salited Lime*, *Salited Magneſia*,—by *Solution of Silver in Nitrous Acid*, which renders the water turbid; and as the marine acid quits every other baſis to unite with ſilver, precipitates it in form of *luna cornea*:—By *ſugar of lead*, which yields clouds, and a white precipitate.

EARTHY BODIES,—as *Lime*, *Chalk*, *Selenite*, *Magneſia*, *Clay*, *Alum*,—by *Solution of Fixed Alkali*,* producing clouds and precipitation:—By *Acid of Sugar*, which produces inſtantly white ſtreaks or clouds, if but a ſingle grain of lime or pure calcareous earth be contained in three pints of the water:†—By a *Solution of Soap in Spirit of Wine*, which inſtantly renders the water turbid.

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* Except *Terra Ponderoſa*, which reſiſts this precipitant; but ſhould it be preſent, it may eaſily be detected by vitriolic acid, which converts it into a ponderous ſpar, and precipitates it in an inſoluble form.

METALLIC BODIES *combined with Acids*,—by *Phlogiſticated Alkali*, which precipitates all metallic ſalts, but leaves thoſe with an alkaline or earthy baſe untouched; hence, on adding it to any water, it ſoon diſcovers by precipitation, whether it contains any metal.

IRON,—as *Vitriol of Iron, Aërated Iron*,—by *Tincture of Galls*, which ſtrikes a dark blue inclining to black, if the iron be vitriolated; purple, if aërated, or ſuſpended by fixed air:—By *Phlogiſticated Alkali*, which, with iron, yields a beautiful Pruſſian blue.

COPPER,—*Vitriolated, Aërated*—by *Volatile Alkali*, which, dropt into the water, yields a blue:—By *Phlogiſticated Alkali*, which gives a reddiſh brown:—By *poliſhed iron*, immerſed in the water, aſſuming a copper colour.

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† Eſſential Salt of Sorrel yields the ſame appearances, though in a ſmaller degree.

Zinc,—*Vitriolated*, or *White Vitriol*,—by *Phlogiſticated Alkali*, which yields a white precipitate, which preſerves its colour even under calcination.

Manganese,—*Salited*,—by *Phlogiſticated Alkali*, which alſo affords a white precipitate, but which grows black by calcination.

Arsenic,—*Calciform*,—by caſting the reſiduum after evaporation, on red-hot iron, when the arſenic, if any be preſent, will emit an odour like that of garlic.

Sulphur,—as *Hepar Sulphuris*, *with Alkali*,—*with Lime*,—by fetid odour, like that of a foul gun:—By turning white arſenic yellow, and converting it into orpiment:—By rendering ſilver black:—By *concentrated acids*, which render the water milky, and precipitate the ſulphur yellow, when united with alkali; white, when with quick lime; and black, with a ſolution of lead in nitrous acid.

Animal or Vegetable Matter,—by *Solution of Mercury in Nitrous Acid*, termed *Nitrated Mercury*, which dropped into the water impregnated by mucilaginous matters, produces white ſtreaks or clouds, followed by a precipitation.

Solid Contents obtained by Evaporation—Cryſtallization—Chemical Attraction.

The nature of the volatile, and other ingredients being thus examined by the moſt approved chemical teſts hitherto diſcovered, we next proceed to collect the ſolid contents for further examination. But they muſt be firſt ſeparated by a long and diligent proceſs, before their reſpective qualities and proportions can be accurately aſcertained. A gallon of the water being ſlowly evaporated in a proper glaſs, or earthen veſſel, the earthy and ſaline matters appear in ſucceſſion according to their degree of ſolubility—the leaſt ſoluble firſt—thus lime and aerated iron take the lead, followed by alum, martial vitriol, nitre, vitriol of copper, mineral alkali, marine ſalt, Epſom ſalt, and laſtly, the deliqueſcent ſalts. The evaporation being gradually continued to dryneſs, the entire reſiduum is to be digeſted in ſpirit of wine, and the liquor filtered. This ſecond reſiduum next, in eight times its quantity of cold diſtilled water, and filtered. Finally, the third reſiduum to be boiled in 500 times its weight of diſtilled water, and afterwards filtered. The remaining reſiduum is now no longer ſoluble either in ſpirit of wine, or water. If iron be preſent, diſtinguiſhable by its *ruſty* colour, let the reſiduum be expoſed to the rays of the ſun for three weeks, and moiſtened from time to time; by which it will be ſo much *dephlogiſticated* as to be inſoluble in vinegar, and its weight may then be aſcertained, with tolerable exactneſs.

The matter diſſolved in ſpirit of wine, is lime, or magneſia united with nitrous or marine acid, both which ſalts may be decompoſed by diluted vitriolic acid. If it be lime, *ſelenite* will precipitate; if magneſia, *Epſom ſalt* will be obtained by evaporation.

The ſalts diſſolved in the cold water, may be ſeparately obtained by cryſtallization. They may be alkaline, earthy, or metallic. Alkaline ſalt is known by its *lixivious* taſte, and *efferveſcing* with acids; and, whether vegetable or mineral, may be determined by diſtilled vinegar, which with the former yields a *deliqueſcent* ſalt; with the latter, *foliated* cryſtals.

Neutral ſalts, compoſed of vitriolic acid, and any baſis whatſoever, may be decompoſed by *Barytes Salita*; if of nitrous acid, the vitriolic will expel it, and the fume will be *red*; if of marine acid, *grey*.

The ſpecies of neutral ſalt may be generally diſtinguiſhed by the *figure* of the cryſtals. If the acid be *vitriolic*, it may be doubtful whether the baſis be *mineral alkali*, or *magneſia*; that is to ſay, whether it be a *true* or *ſpurious* glauber ſalt, from the ſimilarity of their cryſtals. If it be the former, and a bit of the ſalt be immerſed in lime water, the ſolution retains its *tranſparency*; if the latter, it inſtantly exhibits whitiſh *clouds*. If the acid be the *marine*, the ſpecies of alkali may be diſcovered by adding the acid of tartar to a ſolution of the ſalt; if it be the *vegetable* alkali, a genuine *tartar* will be precipitated; if *mineral* alkali, no *decompoſition* will enſue. If the baſis of the marine acid be *calcareous earth*, the vitriolic acid will decompoſe it, and form *ſelenite*. If *magneſia*, *Epſom* ſalt; if *clay*, *alum* will be produced. If *copper* be the baſis, volatile alkali will render the ſolution *blue*; if *iron*, tincture of galls will turn it *purple* or *black*.

The reſiduum of the ſolution made by boiling water conſiſts of *ſelenite* only, which may be either ſeparated by *cryſtallization*, or decompoſed by a fixt *alkali*.

Criterion, by which the juſtneſs and accuracy of the whole proceſs may be determined.

After the ſeveral ingredients have been carefully examined, and their reſpective proportions determined by weight, or meaſure, it will be yet further neceſſary, for general ſatisfaction, firſt to reduce the ſundry articles, as near as may be, to their priſtine ſtate, and then to recombine the whole with a due proportion of *pure* water, properly impregnated with fixed air.

If the water ſhould at length be found, after a ſecond, or even third repetition of the proceſs, exactly ſimilar, in all its diſtinguiſhing properties, to that of the ſprings from whence it was taken, there certainly needs no further proof of the juſtneſs of the analyſis, or of the importance of the improvements, which this branch of philoſophy has lately acquired.

Though few mineral waters can either demand or deſerve a repetition of ſuch a critical examination—yet the dignity of the ART, and the ſtriking imperfections of former publications, (not to mention the unmerited deriſion, with which their authors have been treated) require that nothing eſſential towards a *new* and *improved* analyſis ſhould be overlooked. In the interim, the preſent haſty ſketch is chiefly meant to ſtimulate others, more competent to the taſk, to ſupply what, through brevity, has been here omitted, and likewiſe ſuch further additions as may ſeem to be wanting, towards the completion of ſo neceſſary and important an undertaking.

Methods by which Salt Water may be ſweetened—Hard Water, corrected—Corrupt Water, purified.

To render ſea-water fit for mariners in long voyages, is an object of the higheſt moment. It has long excited the attention of chemiſts, and alſo of the Britiſh Parliament, and for which the latter have awarded very liberal premiums. Various methods have been propoſed, but that by ſimple diſtillation of ſea-water *alone* has at length been found ſufficient, and has attained a great degree of perfection, both in France and England.

Dr. Irving, by a very ſimple contrivance, for which he obtained a parliamentary reward of 5000l. preſents us with the following improvement:—To the lid of the common kettle for boiling proviſions aboard a ſhip, he has adapted a metallic tube. The freſh vapour which ariſes from boiling ſea-water, paſſes through this tube into a hogſhead, which ſerves as a receiver. In order to condenſe the vapour, the tube is kept cool, by conſtantly mopping it with cold ſea-water. It appears, that 80 gallons of ſea-water, by this method, yielded 25 gallons per hour of freſh water, well taſted, and of leſs ſpecific gravity than the beſt ſpring water in that neighbourhood. The officers, who were preſent, concluded that 500 gallons of freſh water might thus be obtained with the ſame quantity of fuel, in proportion to the time, as is required in the ordinary buſineſs of the ſhip. As the ſhip's kettle is divided in the middle by a partition, one of theſe parts being only in uſe at certain times, the other contains water to preſerve its bottom. Dr. IRVING has availed himſelf of this circumſtance, and by filling the ſpare part of the copper with ſea-water, and fitting on the tube, draws off 60 gallons of freſh water during the boiling of the proviſions, without loſs of time, or any additional fuel.*

It has been long known, though lately announced as a new diſcovery, that by *freezing*, the ice of ſea-water is diveſted of its ſaltneſs, and when thawed, yields *freſh* water. For BARTHOLIN, in his work concerning the uſe of ſnow, (publiſhed many years ago) relates this circumſtance, which ſoon became a matter of ſuch public notoriety, that the thawed ice of ſea-water was afterwards uſed at Amſterdam for brewing.

Captain COOK, in a late voyage round the world, was fortunately ſupplied with freſh water from melting the ice found floating in the ſea; and this water, our celebrated circumnavigator aſſures us, was not only freſh, but ſoft and *wholſome*.

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* See Voyage towards the North Pole, Appendix, p. 205.

This may prove an uſeful hint to thoſe who undertake long voyages towards either of the poles, eſpecially when they begin to experience a ſcarcity of freſh water amidſt frozen ſeas. But whether freſh water be thus obtained from diſſolved ice of ſea, freſh river water, or by a diſtillation of ſea-water, it is quite deſtitute of air, and in an unnatural ſtate; and therefore, notwithſtanding the opinion of the great voyager, may be preſumed not very *wholeſome*. This, however, may be remedied, by expoſing the water for ſome time in open veſſels, that it may imbibe its proper quantity of air from the atmoſphere. Or what, I conceive, would be an additional improvement, it might be impregnated with the aërial acid, by a ſuitable contrivance, as lately invented by the ingenious Mr. Henry of Mancheſter, for impregnating the water of a ſhip. This would impart to the water the briſkneſs of freſh ſpring water, and at the ſame time render it a preſervative, perhaps a *remedy*, againſt the ravages of the ſcurvy, and putrid fevers, eſpecially as the antiſeptic virtues of the aërial acid, are now generally acknowledged. To this acid, chiefly, are the antiſeptic and antiſcorbutic effects of cyder, perry, and ſpruce-beer, to be attributed.

Sea-water, at preſent, being ſo faſhionable a remedy amongſt the ſuperior, and middle ranks of ſociety, and eſpecially among thoſe individuals who revolt at the very idea of being thought *unfaſhionable:* It may not be amiſs to inform them, that this nauſeous potion, indiſcriminately taken, is by no means a matter of indifference; and that the abuſe of ſea-water and ſea-bathing, however *faſhionable*, may, nevertheleſs, ſometimes prove highly detrimental. Moreover, that the peculiar ſickneſs produced by ſea-water, accompanied with enormous vomiting, proceeds from the acrimony and bitterneſs of the marine magneſia, and putrid animal ſubſtances, which *particularly* abound near the *ſurface*.—And finally, that theſe nauſeous ingredients are not to be found at all, or but very little, in ſea-water taken up at the *depth* of 60 fathom; as appears evident from the experiments of that accurate chemiſt Sir T. BERGMAN. Here the water, he informs us, had no bad ſmell; the taſte, though intenſely ſalt, was by *no* means nauſeous, like that which was got at the ſurface.

The reaſon of this difference, probably is, that the immenſe quantity of fiſh, and other animals which die in the ocean, are gradually carried up to the ſurface, and there, by the aſſiſtance of the air, are deſtroyed by putrefaction, which proceſs is greatly aſſiſted by the ſalt which at the ſurface is preſent preciſely in the quantity, neceſſary to promote that operation.

On analyſing the water taken up at the above depth, he obtained, from a meaſure containing about three Engliſh pints,

		Ounces.	*Grains.*
Of common ſalt	—	2	433
Marine magneſia	—	0	380
Selenite —	—	0	45.*

Sea-water has been generally obſerved to contain more common ſalt in *hot*, than in *cold* climates, and the quantity to vary in different ſeas, according to the greater or leſs evaporation, or acceſſion of freſh water, from about $\frac{1}{30}$ to $\frac{1}{20}$th of the weight of the water. Thus the Baltic ſea is very weakly impregnated; the Engliſh, and German, more ſtrongly; the Mediteranean, ſtill more; and the Moſambique much ſalter even than this.†

The ſaline ingredients are found in different quantities and proportions, but the quantity of *common ſalt* is always greater than that of any other, amounting on an average, to the proportion of water, as 3, or 4, to 100; ſo that the ſtrongeſt ſea-water is far below the point of ſaturation; water being capable of diſſolving nearly a fourth part of its weight of common ſalt.

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* BERGMAN's Chem. Eſſ. v. i. p. 230.

† Mem. de l' Acad. Par. 1711.

Count **Marsigli**, after a long courſe of experiments, concludes, that in order to ſhew the different nature of ſea-water, in various places, three liquors *alone* are neceſſary to be carried abroad as very ſufficient for that purpoſe, viz.

1. A ſtrong infuſion, or tincture of mallow flowers,
2. Spirit of ſal ammoniac,
3. Oil of tartar per deliquium.

The firſt communicates to ſea-water a greeniſh yellow; the ſpirit of ſal ammoniac renders it turbid, and produces a ſlow precipitation; oil of tartar occaſions the ſame change, but far more ſuddenly. By attentively marking theſe changes, and tinges of colour, and noting the quantity of matter precipitated, he was enabled (as he imagined) to aſcertain the ſtrength of the impregnation of ſea-water, taken up at different places, and at various depths, and alſo to determine the purity of ſea-water diſtilled, or ſweetened by other methods. On pure diſtilled water, no change was produced; the leſs pure, the more viſible the changes of colour, and quantity of precipitate.

Three yet more *exquiſite* teſts of the preſence of marine ſalts with alkaline or earthy baſes might, however, have been added by the noble Count; ſuch are, I preſume, with deference to his ſuperior

judgment

judgment—a ſolution of *ſilver* in the *nitrous* acid—*Barytes Salita*—and *acid* of *ſugar*. The *firſt* detects the ſmalleſt veſtige of *marine* acid; the *ſecond*, of *vitriolic*; and the *third*, of *earth*, or *lime*; and are ſo far likewiſe applicable towards aſcertaining theſe principles in *all* other waters, and that with ſuperior accuracy; though ſtill by no means ſufficient, like thoſe of Count MARSIGLI, to ſuperſede the uſe of *all* other precipitants.

For the waters of the ocean may be conſidered as containing a general aſſemblage of almoſt all the bodies in nature, that are either capable of being ſuſpended or diſſolved in an aqueous menſtruum.

As the impregnation has been found to differ ſo widely in different places, and at different depths, there muſt be many other ſubſtances contained in it, beſides thoſe obtained by BERGMAN from a purer kind of ſea-water, taken up at 60 fathom. Both the ſuperior and inferior ſtrata, comprehending a vaſt body of water, remain yet to be further explored.

The aërial and ſulphureous qualities, together with the impregnations ariſing from the exuviæ of decayed animal and vegetable productions, muſt therefore be referred to thoſe who may incline to favour the learned world with (what is much wanted) an IMPROVED ANALYSIS of ſea-water.

Hard

Hard Waters.

Waters termed *hard* are diſtinguiſhed by curdling ſoap, and by depoſiting a hard earthy incruſtation on the bottoms of tea-kettles, and other veſſels in which they are boiled; and yet ſuch are many of our moſt noted ſprings. Hence thoſe waters which are generally extolled for their *great purity*, are commonly, of all others, the *leaſt pure*.

Though perfectly clear and tranſparent to the eye, and grateful to the palate, they are nevertheleſs (however paradoxical it may appear) extremely hard, and conſequently impure. It is certain that ſuch waters, when brought to the teſt, are generally found highly impregnated with calcareous ſpar, or gypſum, often to the amount of an hundred grains or upwards in a gallon.

There are other hard waters, which are not only impure, but extremely unpalatable, having an auſtere, bitter, or aluminous taſte, which render them improper for internal uſe.

Hard waters, in general, are found unfit for bleaching, waſhing, boiling leguminous vegetables, and many other purpoſes of œconomy and arts.

The *hardneſs* of waters has been attributed, by ſome writers, to *common ſalt*; but Dr. Home, in his experiments on bleaching, has ſhewn that neither common ſalt when *pure*, nor any other ſalt with an *alkaline* baſis, can produce this effect. The ſalt which is in *common* uſe may indeed ſeem to afford an exception, as it contains a portion of abſorbent earth, and is by no means pure.

The aërial acid, ſeparate, or combined with earth or iron, is one cauſe of the hardneſs of waters; but this is eaſily remedied by boiling, or even expoſing the water ſome time in open veſſels, by which means this ſubtil gas exhales. The earth, or iron, which had been ſuſpended by it, being now no longer ſoluble in the water, are precipitated, and the water is immediately rendered ſoft.

Whenever the aërial acid eſcapes, the bond of union is deſtroyed, and the earthy matters attach themſelves firmly to the ſubſtances they happen to meet with. Hence it is that tea-kettles are ſo frequently covered with an earthy cruſt. Hence too, the ochrey ſediment of chalybeate ſprings expoſed to the open air.

Thus, mineral waters, weakly impregnated, might, by mere boiling and cooling, (if other water ſhould be ſcarce) ſtill be rendered uſeful for domeſtic purpoſes.

If the calcareous earth be united with the vitriolic acid in form of ſelenite, as moſt commonly happens, or even with the nitrous or marine acid, *this ſpecies* of hardneſs cannot be corrected by boiling *alone*, but may be accompliſhed by a *fixed alkali*; becauſe alkalis prefer acids to earths, and therefore precipitate their earthy baſis.

Thus alſo hard waters decompoſe ſoap; the acid of ſelenite, uniting with the alkali of the ſoap, leaves the oil and calcareous earth in a ſtate of inſolubility.

Water containing ſelenite inſtantly becomes turbid by the addition of a few drops of ſolution of ſilver, or of mercury in the nitrous acid. Here a double attraction takes place; the ſilver quits the nitrous, to unite with the vitriolic acid, while the calcareous earth quits the vitriolic acid to unite with the nitrous.

In order therefore to correct the hardneſs proceeding from ſelenitic ſalts, let a ſolution of pot-aſh, or any fixed alkali, be added to the water, ſo long as it produces any turbidneſs. When no more is found to fall, the decompoſition is effected, and the earth entirely depoſited. It is eaſy to determine, by weighing the ſolution of the alkali previous to the experiment, what proportion of alkaline ſalt any given quantity of the water requires.

The water thus corrected, muſt be decanted off from the ſediment, and though in reality no purer than before, is found perfectly ſoft for œconomical uſes, and much leſs (if at all) detrimental to health; its auſtere earthy ſalt being now converted into a mild neutral—the vitriolate tartar.

Stagnant Impure Waters.

Waters impregnated with mud, clay, or putrid animal and vegetable matters, are generally turbid, unpalatable, and often highly offenſive. Such waters abound in low marſhy countries, and are found extremely unwholſome, particularly in hot climates; where, in conſequence of the immenſe evaporation which takes place, the muddy bottoms of lakes and ditches, replete with myriads of inſects and their ova, are expoſed to a vertical ſun, exhaling a putrid ſtench, by which the ſuperincumbent atmoſphere is extremely contaminated. To this cauſe chiefly may be attributed the frequency of putrid and peſtilential fevers, which, at certain ſeaſons, infeſt theſe countries, and depopulate whole diſtricts.

To render theſe waters fit for internal uſe, the inhabitants have recourſe to the *filtering ſtone*, formed into a ſort of mortar of a ſpongy texture. The water being poured into this, ſoon makes its way through, and is received into a veſſel placed below for that purpoſe.

The Japaneſe place the utmoſt confidence in this filtering ſtone, and attribute their uninterrupted health, and freedom from gout, ſtone, and gravel, to their drinking the water, thus cleared of all its heterogeneous and miſchievous particles. The people of that, and many other adjacent countries, have a ſettled opinion that theſe, and moſt other diſeaſes, ariſe from the impurities of water; and are well aſſured that theſe impurities are thus completely ſeparated by being all ſafely *lodged* in the filtering ſtone:—glad tidings for gouty and gravelliſh invalids! who certainly can have no reaſonable objection to provide themſelves with all convenient expedition, each man, with a ſuitable filtering ſtone. The price of theſe ineſtimable ſtones, doubtleſs, will immediately riſe, at leaſt 50, if not 100 per cent. But then, what joy and triumph will it not afford, thus at once to be able to depoſit their gout, and ſtone, and bid a final adieu to their nurſes, crutches, flannels, and other diſagreeable accoutrements! What unſpeakable pleaſure to triumph over their doctors, and apothecaries—to rally them on their ignorance, and finally, ſet them ever after at defiance!

The matter, it muſt be confeſſed, appears ſufficiently intereſting; but if our venerable invalids will condeſcend, for a few moments, to ſuſpend their triumph, and only put on their ſpectacles and ſift the affair more cloſely, they will, it is to be feared, find no great cauſe for exultation. Should they happen to have a moderate ſhare of knowledge in chemiſtry, they will ſoon begin to ſuſpect there may poſſibly be ſome fallacy, and in further proſecution of the inquiry, they will be convinced of it; and finally will be obliged to conclude, with grief and aſtoniſhment, that the morbific particles of gout and ſtone are too ſubtile to be thus caught, and rendered for ever inactive, by this mode of impriſonment.

But to be ſerious.—Foreign matters ſuſpended by way of *diffuſion*, it is true, may be intercepted by filtration alone. While thoſe which are combined in the way of *ſolution* are incapable of being thus ſeparated. Such are, unfortunately, the earthy compounds which are ſuppoſed to conſtitute the morbific particles now under conſideration; viz. Selenitic ſalts, and calcareous ſpars, which are ſo intimately combined with the water, as to readily paſs through the filter along with it. So ſtrict is the union, that inſtead of rendering the water *turbid*, they heighten its *tranſparency*, which, by the way, may ſerve to explain the *cryſtalline* brightneſs of certain ſprings, remarkable for their hardneſs.

Whence it appears, that the Japaneſe have been rather too haſty in their concluſions concerning the effects of the filtering ſtone, and too ſanguine in attributing to it their exemption from the above maladies, ſo prevalent among Europeans who neglect it; —a remarkable circumſtance indeed, but which perhaps may be explained on other principles.

The filtering ſtone, though neglected in this country, is nevertheleſs an excellent contrivance, and applicable to various purpoſes, where a paper filter would be entirely uſeleſs. Thus, where the earthy ſubſtances in waters have already been decompoſed by ſuitable precipitants, the filtering ſtone ſeems particularly adapted for ſeparating the terrene matters precipitated, which, by decantation *alone*, can ſeldom be eaſily effected.

Impure waters may, by means of the filtering ſtone, be ſufficiently cleared from living animalculæ, mud, clay, or other matters mechanically ſuſpended in them; but when they are contaminated by marine ſalts, or putrid ſubſtances *diſſolved* in them, it ſeems requiſite that they ſhould undergo *diſtillation*,* or at leaſt a *boiling* heat; and afterwards be expoſed two or three days, in open veſſels, to the *ſolar* and *atmoſpheric* influence.

It appears, from the experiments of Doctor Ingenhouze, and others, and here ſeems particularly worthy of notice, that *pure* vital air is copiouſly generated in water expoſed to the ſun-beams, which water, deprived of the influence of light, yields only *noxious* or contaminated air.

It was firſt diſcovered by Dr. Hales, that impure or corrupted water may be ſweetened by briſk agitation, or by merely paſſing a ſtrong current of air through it, as it is poured from one veſſel to another.

By any of the preceding methods then, might alſo rain water, or the water of ſhips, pools, or ciſterns, (rendered impure or even offenſive by ſtagnation) be undoubtedly meliorated, if not perfectly reſtored.

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* The proceſs of diſtillation, though an effectual method, is too tedious to be often employed, except in caſes of extreme neceſſity, as at ſea.

CHELTENHAM WATER.

Situation of Cheltenham—its Improvements—increaſing Reputation of its Mineral Spring—now termed Royal Spa.

CHELTENHAM is a market-town in Glouceſtershire, near a mile long, ſituated in a ſandy vale, partly environed by high rocks and hills. The air is eſteemed very pure, and the adjacent country extremely fertile. About a quarter of a mile ſouth of the church, adjoining to a ſpacious gravel walk adorned with beautiful elms, riſes the Cheltenham Spa.

The ſpring iſſues very ſlowly from a ſandy ſoil intermixed with loam and a bed of blue clay; and though it has been calculated to yield only about 35 pints in an hour, yet, under the preſent frugal management, it is found adequate to every reaſonable demand of thoſe who drink it on the ſpot.

The well is ſunk about ſix feet deep, and ſhut down with doors that exclude the free communication with the external air, and the water is raiſed by a common pump. The ſides of the well are tinged with a yellow ochre, where a ſaline efflorеſcence has alſo ſometimes been obſerved to germinate.

It is recorded, that the medicinal virtues of this ſpring firſt began to be noticed about the year 1715; ſince which it has been more and more frequented during the ſummer months, and is now become, next to Bath, perhaps one of the moſt genteel and faſhionable places of reſort in the kingdom. Already Cheltenham exhibits a handſome Pump-room, two elegant Ball-rooms, and a Theatre. For which the company are principally indebted to the zeal of the public-ſpirited proprietor of the Spa, William Miller, eſq; who has ſpared neither pains, nor expence, in his laudable exertions for the accommodation of a numerous and polite company.

Since the former impreſſion of this eſſay, I am glad to find that many cauſes of complaint have been removed; that the town has been paved and lighted; the public roads repaired; the inns and lodging-houſes rendered more commodious; and that other important improvements, are now under contemplation.

In the year 1780, SIMEON MOREAU, eſq; was elected Maſter of the Ceremonies, who continues to preſide over the public amuſements; which are, we are informed, conducted with the utmoſt propriety, and that during his adminiſtration the company have increaſed from 374 to 1320!

But to *crown* the whole, this favoured ſpot has lately, in conſequence of the King's indiſpoſition, (and the advice of his Phyſician Sir GEORGE BAKER) been honoured by their MAJESTIES ROYAL PRESENCE. By this welcome, though very unexpected viſit, the ſpring has acquired additional *eclat*, being now diſtinguiſhed by the appellation of the ROYAL SPA *of* CHELTENHAM; but ſtill MORE by its SALUTARY EFFECTS on his MAJESTY'S HEALTH, and by RESTORING the BEST and MOST AMIABLE of KINGS to a loyal and grateful people.

Senſible Qualities of the Water—Specific Gravity—Temperature.

The water, on being poured into a glaſs, appears tolerably clear, though not of a cryſtal tranſparency. After ſtanding a few minutes, air-bubbles are ſeen to collect on the ſides of the glaſs, and at length the water becomes leſs pellucid. When drank freſh at the pump, it firſt imparts a certain ſmoothneſs to the palate, followed by a brackiſh bitter taſte, and emits a ſlightly fetid, or ſulphureous odour. This laſt becomes more perceptible on certain changes of the atmoſphere, and particularly againſt rain. When ſhook briſkly in a cloſe phial, if the cork be ſuddenly drawn, it diſcharges more air-bubbles than common water treated in the ſame way.

Its ſpecific gravity, when freſh drawn, has been computed at 50 grains in a pint greater than that of diſtilled water; and by expoſure to the open air, has ſometimes increaſed to near 70. I have lately found on examining it accurately, after it had ſtood ſeveral months in bottles tight corked and ſealed down, that its increaſed gravity then only amounted to 66 grains.

The temperature of the water, on ſundry trials, and at different times of the day, I perceived to vary between 53 and 55° of Farenheit's thermometer, being a few degrees warmer than ſome of the neighbouring pumps and ſprings, with which it was compared.*

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* The temperature of a well in the adjacent grounds of Lord FALCONBERG, which ſeems to partake of a ſimilar ſaline impregnation, but devoid of the Chalybeate principle, was only 51°, though ſhut up in like manner from the outward air; whereas a new Chalybeate ſpring at the oppoſite extremity of Cheltenham, near the mill, which was opened for my inſpection,

Experiments, exhibiting its appearances with ſundry Precipitants.

Exp. 1. *With tincture of galls,* it inſtantly ſtrikes a vivid purple, which by ſtanding grows darker, inclining to a duſky green, with a variegated pellicle on the ſurface. If a glaſs of the water be expoſed to the open air, it entirely loſes this tinging property in half an hour, and undergoes a manifeſt decompoſition.

2. *Vitriolic Acid* produced a very ſlight ebullition, accompanied with a diſcharge of air-bubbles, and rendered the water more tranſparent. The ſame was afterwards obſerved with the nitrous acid, though in a ſlighter degree. Neither of theſe acids cauſed any precipitation.

3. *Lixivium Tartari* occaſioned a milkineſs, followed by a copious precipitation of a white ſediment.

4. *Solution of Silver in Nitrous Acid* inſtantly produced white clouds, followed by a dark pearl-coloured precipitation of a mucilaginous appear-

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proved nearly of the ſame temperature as that of the Spa, though expoſed to the air.

ance, which afterwards proved to be a true *Luna Cornea.*

5. *Solution of Mercury in Nitrous Acid,* prepared with heat, produced thick clouds, and a brown ruſty precipitation inclining to yellow, after ſtanding ſome time.

6. *Solution of Sugar of Lead* occaſioned white clouds, followed by a precipitation of a whitiſh ſediment, which after ſtanding became brown, inclining to black.

7. *Solution of Corroſive Sublimate* produced a whitiſh cloud, and, after ſtanding ſome time, a ſlight precipitation enſued of a darkiſh colour.

8. *New Milk* mixed uniformly with the water without affording any mark of coagulation, nor did it viſibly coagulate, as ſome have aſſerted, even when boiled with an equal quantity of the water.

9. *Lime Water* rendered it turbid, and a precipitation of the lime enſued.

10. *Soap* diſſolved in the water was immediately decompoſed, and the ſolution put on a curdly appearance.

11. *Syrup of Violets* produced a bright green colour, which, after ſtanding, inclined to a yellowiſh hue.

12. *Common Water diſtilled*, being uſed as a ſtandard, underwent no viſible change on the addition of the foregoing precipitants, except the ſolution of ſilver, which produced ſlight ſtreaks, but without deſtroying the tranſparency of the water, or cauſing any precipitation.

Volatile Contents—how obtained.

13. A pint of the Cheltenham water, freſh drawn into a Florence flaſk, yielded ſpontaneouſly about two ounce meaſures of air into a limber bladder previouſly cleared of its air, and firmly tied to the mouth of the flaſk. And after being placed ſome time in a veſſel of boiling water, it gave out a further quantity, ſo that the whole appeared to amount to three ounce meaſures. The air thus collected was conveyed into a large bottle of lime-water, the mouth of which was inverted in quickſilver, and the whole agitated gently from time to time. Upon which the lime-water became turbid, and a precipitation of the lime enſued. About two-thirds of the air being imbibed by the water, and having precipitated the lime, was evidently fixed air. The reſidue, which appeared to be common air, was

doubtleſs

doubtleſs in a *phlogiſticated* ſtate, for reaſons that will be hereafter aſſigned. The water in the flaſk had now totally loſt its tinging property with galls, and was become vapid to the taſte, on being thus deprived of its aërial principles.

Solid Contents collected by Evaporation.

14. A gallon of the water, being gently evaporated to dryneſs, during the proceſs, threw up to the ſurface a whitiſh pellicle, which afterwards ſubſided, and when the water was conſumed, there was left a brown maſs tinged with ochre. The ſalts obtained from it by repeated elutriation with diſtilled water, and ſubſequent evaporation, weighed - - 485 *grs.*

Reſiduum left in the filter, when dried	70
Total	555

The ſalts ſhot into irregular hexagonal and tetragonal priſms, the two oppoſite ſides broader, truncated at one end, and at the other terminated by quadrangular pyramids; cold, and bitter to the palate, and in appearance extremely ſimilar to the vitriolated mineral alkali, called Glauber's ſalt. Beſides which, were found a few cubic cryſtals amounting to five grains, which proved to be ſea-ſalt, together with a portion of ſaline matter, which towards the cloſe of the evaporation aſſumed a ſoft powdery form, not admitting of cryſtallization, which appeared to conſiſt of a mixture of magneſia with the marine acid. The whole proceſs was now repeated a ſecond time, with the ſame quantity of the water, and nearly with the ſame reſult. The cryſtallized ſalts were preſerved, and afterwards ſubjected to the following experiments.

Properties of the Cheltenham Salts.

15. On diſſolving ſome of the larger cryſtals in diſtilled water, and adding a few drops of a ſolution of vegetable fixed alkali, a white cloud appeared, and remained ſuſpended about the middle of the glaſs.

16. On lime water being dropt into a ſolution of this ſalt in another glaſs, it produced ſmall ſtreaks of a light pearl colour, but no precipitation enſued, whereas a ſolution of common Glauber's ſalt underwent no change from either fixed alkali, or lime water, but remained tranſparent as before.

Theſe two laſt experiments have ſeveral times ſince been repeated with different parcels of the Cheltenham ſalts. While with ſome of the cryſtals, the alkali and lime water produced a milkineſs,

neſs, and even precipitation; with others not the leaſt change enſued, and the ſolution retained its tranſparency after ſtanding, ſimilar to a ſolution of Glauber's ſalt, with which it was compared.

Here the experiments appear to claſh conſiderably, and the difference in the reſult ſeems to render it very equivocal, whether the Cheltenham ſalts are to be conſidered of the *Glauber* or *Epſom* kind. But this difficulty is readily explained:— The experiments prove both theſe ſalts to be preſent, and that thoſe cryſtals which undergo *no* decompoſition with an alkali are real *Glauber* ſalts, while thoſe that *do*, are as clearly *Epſom*.

Nor is this combination incompatible, ſince both are often found in the ſame water; they cryſtallize together, aſſume the ſame appearance, nor can they be accurately ſeparated without a tedious proceſs by double elective attraction, which is by no means neceſſary, as they are known to agree ſo nearly in their medicinal properties. When combined, however, they mutually promote each other's ſolubility, and general operation.—A circumſtance hitherto little known, though worthy to be obſerved in the adminiſtration of other ſaline medicines, as well as thoſe of the purgative kind.

17. On adding a few drops of tincture of litmus,[*] or ſyrup of violets, to a ſolution of Cheltenham ſalt in diſtilled water, no ſenſible change inclining either to red or green enſued; nor was the blue tinge of the litmus rendered more intenſe, neither did any efferveſcence ariſe with acids or alkalis.

18. Paper dipt in a ſaturated ſolution of this ſalt, and then dried, did not deflagrate when applied to the flame of a candle, as it is known to do when dipt in a ſolution of nitre, nor did it burn with a *green* flame, as it is wont to do from a ſolution of calcarious nitre.

19. The Cheltenham ſalt was found to be perfectly ſoluble in nearly its own weight of diſtilled water at the temperature of 60°, and in leſs than two-thirds of its weight of boiling water; whereas the common Glauber ſalt required nearly twice its weight to diſſolve it at the temperature of 60°, and

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[*] Litmus is a blue pigment formed from Archal, a ſpecies of moſs brought from the Canary and Cape de Verd Iſlands. The tincture is obtained by ſteeping this pigment incloſed in clean linen cloth in diſtilled water. A ſingle drop of concentrated vitriolic acid has been found to communicate a viſible red tinge to 300 grains or 408 cubic inches of this blue tincture. Hence its utility as an exquiſite teſt for diſcovering the minuteſt portion of acidity in waters, inſomuch that fixed air itſelf, one of the weakeſt acids hitherto diſcovered, is incapable of eſcaping it without being immediately diſcovered.

5-6ths at the boiling point. Although this ſalt contains near half its weight of water in its cryſtalline ſtate, it did not prove *deliqueſcent* like *calcarious nitre*; but remained permanent in a moiſt air, and, in a dry air, calcined ſpontaneouſly. Thrown on ignited iron, it liquefied, riſing into bliſters, but without affording any detonation like nitre, as ſome have pretended,* neither did it coagulate milk when boiled with it, as others have alledged.†

Of the Reſiduum.

20. The earthy reſiduum, as already mentioned in Exp. 14, which remained inſoluble in water, weighed 70 grains. It effervesced with acids, and turned ſyrup of violets green. The vitriolic acid converted part of it into a ſelenitic ſubſtance, or gypſum, ſimilar to that which forms an incruſtation on the inner ſurface of the kettle, in which the water is occaſionally heated at the Spa.

21. The reſidue, when dried, did not diſcover any magnetic property, till it had undergone a ſlight calcination with charcoal, when ſome minute particles were attracted by the magnet.

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* See Dr. SHORT on Mineral Waters.

† Editor of the 4th Edition of RUSSEL on Sea-Water, 1760. Alſo RUTTY on Mineral Waters;—p. 133.

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The volatile Parts once loſt, whether recoverable.

22. A gentleman who frequents the Spa, having preſerved two bottles of the water 22 years, as a matter of curioſity requeſted me to examine it. The water on being poured into a glaſs was clear, and perfectly free from any bad odour. It turned ſyrup of violets green, but taſted flat; and had entirely loſt its tinging property with litmus, and alſo with galls, agreeably to what I expected.

23. Having ordered two bottles of the water freſh drawn to be well corked and ſealed down at the pump before my departure, I examined it by ſundry experiments ſix weeks after my return to Bath, and found it ſtill retained ſome ſlight degree of ſmartneſs on the palate, and changed tincture of litmus to a faint red, but had quite loſt the tinging property with galls.

24. Leaving the bottle uncorked till the water became quite *vapid*, it was then poured into the glaſs apparatus invented by Dr. NOOTH for impregnating water with fixed air, and expoſed to the effluvia of an efferveſcent mixture of chalk and vitriolic acid, till it was fully ſaturated. It now tinged the litmus of a vivid red; ſparkled on being poured into the glaſs, and taſted briſker than water

freſh drawn at the fountain head. On immerſing a ſmall piece of iron in the water, and leaving it in the veſſel all night, the water next morning had completely recovered the chalybeate quality, ſtruck a deep purple with galls, and finally, on expoſure to the air, threw up a variegated film to the ſurface, which reflected the priſmatic colours.

General Inferences from the preceding Experiments.

I ſhall now proceed to illuſtrate the foregoing experiments, and to deduce from them a few inferences by way of induction.

Exp. 1. The ſundry *precipitants* employed in analyzing waters, it muſt be obſerved, can only ſerve to point out the *quality*, not the *quantity*, of their reſpective mineral ingredients. From this experiment with tincture of galls, it appears, that the water contains iron, which is farther confirmed by the ochrey ſediment which it depoſits on the ſides of the well. A ſingle drop of the tincture is ſufficient to give a diſtinct purple tinge to 100 cubic inches of diſtilled water, containing only three grains of martial vitriol, yet three grains of the vitriol contain no more than $\frac{1}{24}$th of a grain of iron. Where the quantity of iron is conſiderable, inſtead of a purple, it gives a black tinge. When it exiſts in the form of martial vitriol, the colour is more permanent; but when it is ſuſpended by fixed air, it is extremely evaneſcent, as in the preſent inſtance. The reaſon why this water ſo ſoon loſes its tinging quality, will be afterwards more fully conſidered.

2. From this experiment with *vitriolic acid*, we learn that the water contains an *earthy* ſubſtance ſuſpended by means of fixed air. The vitriolic acid, by ſuperior attraction, ſeizes the earth, and forces the air to quit its hold; hence the copious diſcharge of air-bubbles, and increaſed tranſparency. It further appears, that the earth is not of the ſiliceous kind which is inſoluble in water, nor the *terra ponderoſa* (ſometimes ſuſpended in water by fixed air) which would have been precipitated by the vitriolic acid in form of ponderous ſpar. It muſt therefore be referred either to the calcarious, or abſorbent claſs.

3. Here the fixed alkali, by the ſame law of attraction, ſhews the preſence of earth, or a neutral ſalt with an earthy or metallic baſis.

4. *The Solution of Silver*, in this experiment, points out the preſence of *marine acid*, which it enables us to detect in a very large quantity of

water, eſpecially when the precipitate, as in the preſent inſtance, forms a *luna cornea* reducible by calcination to its priſtine ſtate of pure ſilver.

5. *The Solution of Mercury* diſcovers a neutral ſalt, of which the vitriolic acid forms one of the ingredients; but is not ſufficient to determine the nature of its baſis, or whether it be Glauber's Salt, or Epſom; both of which appear to be preſent. The brown ruſty precipitate denotes an impregnation of iron.

6, and 7. *Here the Solution of Lead*, and of *Corroſive Sublimate*, betray ſigns of *hepatic air*, or a very ſlight ſulphureous impregnation, and at the ſame time confirm the preſence of calcarious earth, or magneſia, held in ſolution by means of fixed air.

8. In this experiment, the *ready union of the water with milk*, without producing any decompoſition, ſhews the error of thoſe practitioners who prohibit a milk diet during a courſe of this water, from its ſuppoſed coagulating quality. And the reſult of *exp.* 19, may be ſufficient to correct the ſame popular prejudice, which alſo attributes a coagulating property to the Cheltenham ſalts.

9. *The Precipitation of the Lime*, in this experiment, affords a ſatisfactory teſt of the preſence of

fixed air. The air, having a more powerful attraction for the quick lime than for the water, quits the latter to unite with the former; and thereby renders the lime inſoluble in a watery menſtruum. Hence the turbid appearance, and ſubſequent precipitation of the lime.*

10. *The decompoſition of Soap* argues the preſence of *calcarious* earth, or *magneſia* combined with an acid, which acid detaches the oil of the ſoap from the alkali with which it was combined, and occupies its place. Fixed air, being an acid, is capable indeed of producing a ſimilar effect, though in a far leſs ſenſible degree.

11. *The bright green colour imparted to Syrup of Violets,* inclining to *yellow,* tends to confirm the concluſions drawn from ſome of the preceding experiments, concerning the preſence of *earth,* and particularly of *magneſia.*

Profeſſor Bergman has perhaps too haſtily rejected ſyrup of violets from the claſs of chemical teſts, becauſe he thinks it can ſeldom be had genuine; that it ſpontaneouſly acquires a red colour by fermentation; and finally, that it is rendered green, not only by *earths* and *alkalies*, but alſo by *iron*. Theſe inconveniences, it is true, occaſion ſome ambiguity, but may be eaſily obviated. For,

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* Here it is not a little curious to obſerve, that if a certain portion of fixed air be added, the lime is preſently re-diſſolved, and the water immediately recovers its former tranſparency. If an additional quantity of lime-water now be added more than ſufficient to ſaturate the fixed air, the turbid appearance inſtantly returns, and theſe changes may be alternately renewed at pleaſure.

1ſt. The *genuine* ſyrup is readily diſtinguiſhed by changing a ſolution of corroſive ſublimate *green*, while that which is *ſpurious* turns it *red*.

2dly. The alteration produced by ſpontaneous fermentation is too palpably perceived before hand, to deceive even a common obſerver.

3dly. Whoever has compared the green produced by *iron* with that produced by *alkalies* or *earths*, will eaſily be enabled to diſtinguiſh them on every future occaſion.

To a ſolution of a ſingle grain of martial vitriol, and of each of the other ſubſtances, in a wine-glaſs of rain or diſtilled water, add half a tea ſpoonful of *genuine* ſyrup of violets. After ſtanding, it will be found, that the vitriol yields a *dull* green inclining to *black*; the alkali, a *bright* green; chalk, a *light* green inclining to *blue*; magneſia, a lively bright green with a *yellowiſh* caſt, as in the above experiment.

The blue juices of other vegetables, though much eſteemed, are unequally affected by acids, and alkalies.—Litmus, inſtead of *green*, is rendered more intenſely *blue* by *alkalies*. Indigo, inſtead of growing *red* with *vitriolic acid*, undergoes *no* change of *colour*. Turnſole, and Litmus, are turned *red* by fixed air, while the *other* vegetable blues remain *unchanged* by this weak acid. Where certainty can only be attained by the coincidence of many reſults, ſyrup of violets, with the above cautions, may reflect no ſmall light, and therefore ought in no wiſe to be diſcarded from the place which it has long deſervedly held in the claſs of re-agents.

12. *This experiment with diſtilled water* affords a ſtriking contraſt between the effects of precipitants on the *Cheltenham* water, and *ſimple* water free from any mineral impregnation. For the appearance obſerved with Solution of Silver, can only be attributed to ſome ſlight *accidental* impurity. Nor can this be entirely avoided, even when the water is repeatedly diſtilled from the pureſt ſnow.

13. *This experiment* preſents us with an *aërial fluid*, a conſiderable portion of which being looſely attached to the water, exhaled ſpontaneouſly into the bladder placed to receive it, while the reſidue being more cloſely united to the terrene parts, re-

quired a boiling heat to detach it. The quantity obtained by this, and the former proceſs, amounted to about four ounce meaſures, three-fourths of which were *readily* imbibed by water; and, as this portion decompoſed lime-water and reddened litmus, was undoubtedly fixed air, and the reſidue may be ſafely conſidered as *phlogiſticated*, becauſe *pure* atmoſpheric air is *incompatible* with the preſence of *iron* and *hepatic gas*; ſince by ſeizing the phlogiſton, it decompoſes the metal, and becomes *phlogiſticated*.

To aſcertain the quantity of aërial fluids in a given quantity of water with exactneſs, is by no means eaſy. The method propoſed by Sir T. BERGMAN, at firſt view, appears preferable to that which, through neceſſity, I here had recourſe to. His apparatus indeed is eſteemed the leaſt exceptionable of any that has been invented. I have ſince found, however, that it is liable to much greater fallacy, from the rarefaction of the air in the tube of the retort, than the learned Profeſſor ſeems to have been aware of. Nor is the method propoſed by M. GIOANNETTI, and other foreign chemiſts, more to be depended on. They endeavour to determine the quantity of fixed air by *weight*, rather than by *bulk*, eſtimating this by the weight of the calcarious earth precipitated by it from lime water. But the difference in the reſult of their calculations evidently proves that it is not leſs difficult to determine with *preciſion* the quantity of fixed air contained in calcarious earth, than the proportion which the bulk of this fluid bears to its weight.

The ſpontaneous evaporation of the aërial volatile parts (when no artificial heat is applied) may aſſiſt us in explaining the increaſed ſpecific gravity of the water, after ſtanding ſome time in an open veſſel.

14. From the experiment by evaporation, we aſcertain with more certainty the quantity of neutral ſalts, and other ingredients of a fixed nature, contained in a gallon of the water, each of which ſhall be now conſidered.

Its Purging Salts—whether Vitriolic—or Nitrous —how diſtinguiſhed.

15, 16. From theſe experiments it appears, that the purging ſalts of this water conſiſt of vitriolated mineral alkali, and vitriolated magneſia; or, in more familiar terms, of an aſſemblage of Glauber and Epſom Salts. Some have ſuppoſed theſe two ſalts to be perfectly ſimilar. They, agree, it is true, in their ſenſible qualities, and frequently correſpond in the form of their cryſtals. The acid is the ſame in both; they differ however in their baſis. The Glauber ſalt having the *mineral alkali* for its baſis; the Epſom ſalt, *magneſia*. Hence a ſolution of the former remains undiſturbed by the addition of a fixed alkali, or lime water, while the latter grows cloudy, and undergoes a decompoſition. Theſe ſalts therefore are eſſentially different, though apparently combined in the water, which is no uncommon circumſtance among ſaline waters of this claſs. The cryſtals of the Epſom ſalt are ſometimes ſo large, that they are ſold in England for Glauber's ſalt; and on the other hand, in France, Glauber's ſalt, being reduced to ſmall *ſpiculæ* by agitation during the cryſtallization, is vended for Epſom. But theſe petty frauds may be eaſily detected by the addition of lime water, or a fixed alkali, either of which afford an infallible teſt, agreeably to what has been already hinted.

17. This experiment ſhews, that the Cheltenham ſalts are neither acid nor alkaline, but as perfectly neutral as the pureſt Glauber or, Epſom ſalts of the ſhops, when duly prepared. Nor can there be any material difference between the natural, and artificial, either in their chemical or medicinal qualities, when reduced to the ſame degree of purity.

18, 19. Afford inconteſtible evidence that the ſalt of this water, which has been pronounced to be *nitrous* by Dr. SHORT, and repeatedly echoed as *ſuch* by ſucceeding writers, does not, in truth, bear the remoteſt analogy to nitre, nor yet to the νατρον of the ancients, (termed *foſſil alkali* by the moderns) neither of which are of a purgative nature. Neither does it bear any reſemblance to *calcarious* nitre, as others have aſſerted; for the Cheltenham ſalt yields *permanent* cryſtals; the calcarious nitre, a *deliqueſcent* maſs, incapable of a perfect cryſtallization. The Cheltenham ſalt is an *active purgative*; the nitrous ſalts poſſeſs *no purgative* quality whatſoever.

The reaſon why the Cheltenham ſalt (in *experiment* 19) proved ſoluble in ſo ſmall a proportion of water, may perhaps be thus accounted for: 100 grains of this ſalt contain of vitriolic acid about 19 parts; of pure magneſia, 33; of water, 50. The water eſſential to the cryſtals of this ſalt, being ſo very conſiderable, muſt proportionably increaſe the menſtruum, and conſequently promote the ſolution.

Thus water, after being fully ſaturated with ſal ammoniac, becomes capable of diſſolving a much larger quantity of corroſive ſublimate than the ſame quantity of plain water can hold in ſolution, becauſe the water eſſential to the ammoniacal ſalt, is

now

now ſuperadded to the menſtruum; of which many ſimilar inſtances have been already mentioned in the preceding Eſſay on Water.

20. This experiment ſhews, that the earthy reſiduum contains a ſelenitic matter as well as magneſia, and that the latter is combined with fixed air; which, being diſlodged by the more powerful acids in this experiment, produces a conflict, and flies off during the effervеſcence.

21. This confirms the reſult of the experiment with galls, concerning the preſence of iron, and ſhews it to be in a calciform ſtate. By calcination with an inflammable ſubſtance, it acquires the neceſſary portion of phlogiſton to render it ſenſible to the loadſtone, though not ſo much as is required to reduce the calx into its metallic ſtate.[*] With reſpect to the quantity of iron contained in the water, it is undoubtedly ſmall. Dr. LUCAS eſtimates it at four grains in a gallon: but it is by no means eaſy to aſcertain this with accuracy, or to

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[*] Iron, though hitherto conſidered as a *ſimple* metal, has lately been diſcovered to contain a portion of *Plumbage* and *Maganeſe.* How far the union of theſe ſubſtances may influence its compoſition, or vary its effects in medicine or the arts, may prove an object worthy inquiry, particularly in England, where this metal undergoes ſo many different proceſſes, and exerciſes the ingenuity of ſo many expert chemiſts, and artizans.

collect the calx in a ſeparate ſtate by the uſual method of filtration, without waſte, and therefore it was not here depended on. If we may be allowed to judge from the purple tinge communicated to diſtilled water by an adequate proportion of martial vitriol, the iron contained in a gallon of Cheltenham water, may be preſumed to amount to four grains and a half, if not five grains.

22, 23. We have already ſhewn, by *Exp.* 1, that the water when expoſed to the air in an open veſſel, in the ordinary temperature of the atmoſphere, was deprived of its purple tinging quality, in half an hour. This decompoſition of the chalybeate principle firſt takes place at the ſurface, which is moſt expoſed; the phlogiſton of the metal being attracted by the dephlogiſticated air of the atmoſphere, the iron is decompoſed. Hence the variegated film. The water, when tight corked, and ſealed down, was found at the end of ſix weeks to communicate a very faint red to the tincture of litmus, and therefore to have retained part of its fixed air, though not ſufficient to ſuſpend the chalybeate principle; for it no longer gave a purple tinge with galls. It is no wonder then that the bottle which had been kept the ſpace of twenty-two years, was found to have totally loſt both theſe properties.

How to preſerve the Mineral Spirit—or to recover it when loſt.

24. It has long been a received maxim, that mineral waters, eſpecially thoſe of the chalybeate kind, can only be drank in perfection at the fountain head, and that when their mineral ſpirit (as it is termed) is once loſt, the chalybeate principle vaniſhes; and that both are totally irrecoverable. The experiment, however, (page 58) affords a remarkable example of the contrary, and alſo points out an eaſy and ſimple method, by which both theſe fugitive principles may again be completely reſtored:——A pleaſing circumſtance to thoſe perſons who cannot attend the ſpring, but are obliged to ſend for the waters at a great diſtance. It alſo ſupplies a convincing proof of the *real* nature of the mineral ſpirit, and its *perfect identity* with fixed air: that by the intervention of this ſubtile medium, the iron is converted into a ſaline ſubſtance, and in that ſtate is naturally diſſolved in the water. That when this flies off, the iron does not accompany it, as is vulgarly ſuppoſed, but only ſubſides, and is depoſited at the bottom of the bottle, in form of ochre.

It is obſervable that iron cannot be duly ſuſpended in water by fixed air, either naturally, or artificially, without a ſuperabundant quantity of air, beyond what is merely neceſſary to the ſolution of the iron. In order, therefore, to preſerve a chalybeate water in its full efficacy, it is neceſſary to re-impregnate it occaſionally with iron, and alſo with an additional quantity of fixed air, till it is ſuper-ſaturated with the latter.

Some attempt to preſerve the mineral ſpirit of theſe waters, when intended for tranſportation, by pouring a little olive oil into the neck of the bottle before it is corked; but this method is very exceptionable, and inadequate to the intention.

The mineral ſpirit is too ſubtile to be wholly confined by a thin ſtratum of oil. The oil is moreover apt to contract a rancid quality, which it ſoon imparts to the water, and renders it offenſive.

Others, ſtill more improperly, direct the water to be kept in a warm room. This produces an inteſtine motion in the mineral contents, which detaches the aërial principles, and ſoon renders the water vapid.

Here, I ſhall attempt to explain a chemical problem, which has long perplexed Philoſophers, namely, the decompoſition which certain chalybeate waters undergo, even in bottles *hermetically* ſealed, and when every other precaution has been uſed to prevent it. The cauſe appears to be this: Though glaſs be impermeable to aërial fluids, yet the principle of *heat* (which in *certain quantity* is eſſential to their compoſition) eaſily pervades the pores of glaſs, and even penetrates the denſeſt metals. The eſcape alſo of this ſubtile medium inſtantly renders the menſtruum incapable of ſuſpending the mineral contents, with which it was connected, and hence a decompoſition, and precipitation muſt inevitably enſue.

Water, I find, imbibes fixed air more powerfully in a cold, than in a warm ſeaſon, and retains it more tenaciouſly in proportion as its temperature approaches the freezing point: and yet, what is remarkable, the moment it undergoes congelation, it loſes it entirely, for ice-water is deſtitute of fixed air. Hence the preſence of fixed air appears to be incompatible with water, as ſoon as the latter approaches to a ſolid form: conſequently, to preſerve a permanent union between them, the extremes both of heat and cold muſt be carefully avoided. The briſker kind of mineral waters, therefore, whoſe chalybeate principle is ſuſpended by fixed air, ought to be kept in a cool cellar of equal temperature, the bottles being well ſecured, and placed with the corks downwards.

By theſe means the foreign mineral waters, imported at a great expence, might be preſerved in a much higher degree of perfection than we commonly find them. Even in their preſent ſtate, they might be conſiderably improved by re-impregnating them with fixed air; though this, I find, is by no means ſufficient to enable them again to take up the ochrey ſediment, after being once depoſited.—Why?

Principles contained in a Gallon of the Cheltenham Water.

From the preceding experiments, a gallon of the Cheltenham water (wine meaſure) appears to contain the ſubſequent principles, and nearly in the following proportions, viz.

Of Solid Contents.

	Grains
Purging ſalt, partly Glauber, partly Epſom,	480
Marine ſalt - - -	5
Iron, combined with fixed air, nearly	5
Magneſia, combined partly with marine acid, partly with fixed air	25
Calcarious earth, combined with vitriolic acid in form of ſelinite	40
Total	555

	Ounce Meaſures
Fixed air, combined with the water,	24
Phlogiſticated air, with a portion of hepatic air alſo looſely combined with the water	8
Total	32

Excluſive of a ſmall portion of fixed air, retainable by the earthy ſubſtances, even in the heat of boiling water, or liable to be re-abſorbed during the proceſs. Nor ought a ſlight difference in the reſult of experiments to be wondered at, ſince not only the aërial fluids, but alſo the more ſolid contents of mineral waters, are found to vary at certain ſeaſons, and according to ſubterranean changes, which are continually going on in the bowels of the earth.

By the term *Hepatic Air*, is meant ſulphur converted into a volatile ſtate, by union with the principle of heat. In conſequence of this combination, it aſſumes the form of a permanently elaſtic gas or vapour, and becomes miſcible with water. Though extremely fugitive in its nature, yet it is ſufficiently diſtinguiſhable by the peculiar fetid odour with which it not only impregnates the water, but alſo the alvine diſcharges of thoſe who drink it. Dr. Lucas aſcribes this odour to a putrid taint, in conſequence of the water being ſhut up from the common air. But then why is there not a ſimilar odour perceptible in the water of other wells, and pumps ſhut up equally cloſe? beſides, does not the conſtant influx and reflux of the ſpring, not to mention the antiſeptic quality of the fixed air, and neutral ſalts with which the water is impregnated, ſtrongly militate againſt this *ſuppoſed* putrid quality? Others, with much greater probability, have attributed it to ſulphur in its own proper form; but ſince the water neither undergoes any precipitation of ſulphur by concentrated nitrous acid, nor diſcolours poliſhed ſilver when immerſed in it, we muſt not expect to obtain *real* ſulphur from the water, though its conſtituent principles are evidently preſent in a volatile evaneſcent ſtate.

Here, the preſent weak impregnation of the hepatic gas the more eaſily eludes the common teſts, than where the water is more fully ſaturated with it. May not this ſubtile vapour derive its origin from a decompoſition of the ſulphur contained in the pyrites or iron ore, which ſupplies the Chalybeate principle? and may not the action of *pure* air on its phlogiſton, extricate the principle of heat eſſential to the volatilization of the ſulphur? and finally, may not this alſo explain why the water is rather warmer than the neighbouring ſprings, and its air in a phlogiſticated ſtate?

Now whether theſe conſtitute the whole contents of the water, or whether there may not be ſome other *unknown* principle, ſome link of the chain yet wanting, I ſhall not venture to decide. For the recompoſition (as has been already obſerved) ought exactly to correſpond with the decompoſition, and a reunion of the different principles ought to be capable of reproducing the natural water, before the analyſis can be pronounced abſolutely complete.

But this doubtleſs is a moſt arduous taſk, and it muſt be confeſſed, that the reſearches of our beſt writers on Mineral Waters have rarely, if ever, attained ſo high a pitch of ſatisfactory evidence; nor was there opportunity of putting the matter to the teſt in the preſent inſtance, becauſe the entire contents were previouſly ſubjected to other neceſſary experiments. The rapid progreſs of philoſophical chemiſtry, however, encourages us to hope, that it may ſtill be accompliſhed at no very diſtant period. And that in the interim, a more accurate inveſtigation of the mineral ſubſtances with which nature impregnates waters, may enable us, in time, more fully to comprehend her hidden proceſſes, and finally to produce *artificial* impregnations that may emulate, or perhaps even ſurpaſs, the *natural* ones. For, admitting the quality and quantity of the ſeveral ingredients to be once thoroughly underſtood, it is humbly conceived that no very eſſential difference can ariſe from the hand that combines them.

Their Medicinal Properties ſeparately conſidered.

Here the reader will naturally expect ſome account of the medicinal virtues of the ſeveral component parts of this water in a ſeparate ſtate; but ſuch an account, though ever ſo circumſtantial, it is feared, would fail of conveying the deſired information concerning the genuine effects of the water when drank freſh at the ſpring. Many of its principles are of an active nature, ſome apparently inert; but the medical effects of the compound are often very different from what might be expected from the known qualities of the ingredients; therefore we muſt look for its medicinal virtues in the *aggregate*, rather than in the *conſtituent* parts, though *both* ought to be carefully explored.

It may be proper to obſerve in general, that the neutral purging ſalts, which abound in this water, are the chief ingredients wherein its purgative qualities evidently reſide. Their virtues agree with thoſe of the artificial Glauber and Epſom ſalts; but the ſuperior ſolubility of the Cheltenham ſalt, containing an union of the two, becomes a more active purgative than either of them taken ſeparately; and this quality is greatly heightened by very copious dilution. Hence a quarter of an ounce of the ſalt contained in a quart of the water, operates more briſkly than a whole ounce of common Glauber ſalt when diſſolved only in two ounces of water.

Hence the impropriety of adminiſtering purging ſalts in ſuch a trifling quantity of the menſtruum; and yet this is the faſhionable method generally adopted by modern practitioners, who, in compliance with cuſtom, limit every draught to a ſmall two-ounce phial, which in fact contains little more than an ounce and half. In this quantity of water is an ounce of the ſalt directed to be diſſolved; and to complete the abſurdity, it is generally interlarded with manna, ſenna, or tamarinds, when, for want of proper dilution, when cold, the mixture preſently congeals into an unſightly coagulum, with the ſalt firmly cryſttallized.

The Cheltenham ſalt being prepared in conſiderable quantity from the water at the Spa, in a portable form, its cryſtals may be preſerved in bottles unimpaired by time, and may be uſefully employed at a diſtance from the ſpring, as a ſafe and gentle purgative. It may alſo afford an uſeful ſubſtitute for the water itſelf in inflammatory, or hectic diſorders, where the chalybeate principle might be deemed improper. By adjuſting the doſe, it may be determined to operate as a briſk purgative, or mild laxative and diuretic, and may therefore be added occaſionally to quicken the operation of the water, when it paſſes off too ſlowly; or may be diſſolved in a moderate quantity, where large draughts of cold water are deemed improper, as in hydropic and leucophlegmatic habits.

The *Sea-Salt*, though very minute in quantity, may, when largely diluted, contribute its ſhare to the purgative and diuretic effects of the other ſaline ingredients. And as this ſalt has the ſingular property of paſſing, unaltered in its nature, through the ſeveral ſtages of circulation; and after all, of being recoverable from the blood and urine of animal bodies, its deobſtruent effects in the remote parts of the frame may be more conſiderable, than has been generally imagined. Does not the known efficacy of ſea-water in this reſpect, even when drank in ſmall quantities as an alterative, tend to corroborate this opinion?

The IRON combined with the AERIAL ACID conſtitutes an active ſaline chalybeate, which contributes to warm and invigorate the ſyſtem, to promote appetite and digeſtion, and to prevent languor during the evacuation.

The MARINE MAGNESIA, as a laxative and abſorbent, tends to correct acidities, and vitiated bile in the firſt paſſages, and to promote their expulſion. It may alſo increaſe the purgative and diuretic power of the other neutral ſalts.

Whether the CALCARIOUS OR SELENITIC MATTER can really impart any uſeful medicinal quality to this, or any other water, ſeems very problematical. It requires at leaſt 500 times its weight of boiling water to diſſolve it, and may therefore be conſidered as almoſt inſoluble by the animal fluids. Waters which abound with it are extremely hard, and generally unfit for culinary purpoſes; and the inhabitants who are obliged to drink them, are often infeſted with the Bronchocele,* and other glandular tumors. The Caroline water, indeed, as well as ſome other hard waters, have been extolled in caſes of ſtone and gravel; but their virtues, which have been erroneouſly aſcribed to the earthy matter, may, I think, be more rationally explained from the fixed air and mineral alkali which they contain.

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* A large tumour of the neck, to which females are peculiarly liable where hard waters abound. At the foot of the Alps it is ſaid to be endemic, alſo in the Peak of Derbyſhire; hence the diſeaſe has been termed the DERBY NECK.

However improbable the theories may be which have been advanced concerning the nature and operation of ſuch ſprings, I ſhall at preſent paſs them over in ſilence. It is ſufficient to obſerve that the Cheltenham water, by its purgative and diuretic qualities, expedites the paſſage of theſe terrene matters through the ſyſtem, ſufficiently, at leaſt, to obviate their bad effects.

Fixed Air, though an important principle in this water, ſeems to have been unknown to the more early writers; and the moderns, among whom Dr. Lucas, ſeem to have ſtrangely confounded it with the volatile vitriolic acid, from which, however, it is very eſſentially different. The volatile vitriolic acid is eaſily diſtinguiſhable by its irritating corroſive quality, which deſtroys the colours of organized bodies; alſo by its ſtronger attractive power to other ſubſtances, and by being condenſible into drops of genuine vitriolic acid. Fixed air, on the contrary, is a milder acid, is void of acrimony, and even deſtroys the cauſticity of other ſubſtances.

In its ſeparate ſtate, it is not condenſible into drops, but remains a permanently elaſtic fluid.

The properties of fixed air, indeed, have not been minutely examined till of late, notwithſtanding it is almoſt every where preſent; inſomuch, that few waters are wholly diveſted of it, except thoſe of ice and ſnow; which perhaps may be one reaſon why theſe waters prove ſo unwholſome when uſed internally, unleſs, by previous expoſure in open veſſels, they are ſuffered to re-imbibe a proper quantity of this enlivening fluid from the atmoſphere.

Though it appears to be much leſs predominant in the Cheltenham Spa, than in ſome of the more briſk acidulous waters, yet we find (from experiment 13) that the quantity even here is by no means inconſiderable. It is that portion alone which is looſely attached to the water, ſo as to be ſeparated by the heat of boiling water, which can impart any active medicinal power to the water. The reſidue, which adheres cloſely to the earthy baſis, ſo as to reſiſt this degree of heat, cannot perhaps be diſlodged by any other proceſs, except congelation or calcination: and therefore is probably too inert to exert any medicinal virtues, or to merit any further conſideration at preſent.

It appears from obſervation, that fixed air communicates to ſimple water, an antiſeptic, diuretic, exhilarating, and even inebriating quality. It is evidently this aërial principle which gives the agreeable ſmartneſs and poignancy to mineral waters, and which imparts life and energy to the other ingredients, by which they are enabled to pervade the remoteſt receſſes of the human frame, and ſubdue ſome of the moſt obſtinate diſeaſes. To what other principle in their compoſition can we rationally attribute theſe ſurpriſing effects? Not ſurely to the water alone, which is totally incapable of producing them; nay even injurious, when diveſted of this neceſſary ingredient in its compoſition; much leſs to the mere ſolid contents, which, either jointly or ſeparately conſidered, are too inactive to exert ſuch extraordinary powers.

The Phlogisticated and Hepatic Air, which alſo appear to enter the compoſition of this water, may produce powerful effects proportionate to the peculiar nature of ſuch ſubtile fluids. The medicinal powers of the *former* are as yet wholly unknown: the *latter* may be expected to impart to the water virtues ſimilar to thoſe of Harrowgate, and other ſulphureous ſprings, in proportion to the degree of impregnation. Hence, perhaps, may be explained why this water is more efficacious in certain cutaneous diſeaſes, than ſome other ſaline waters, which are deſtitute of the ſulphureous gas.

The medicinal properties of both theſe elaſtic fluids are ſtill too little underſtood to warrant us in drawing *a priori* any certain concluſions concerning them. It may however be obſerved in general, that from experiments it appears that fixed air, phlogiſticated air, and hepatic air, agree in their known properties of extinguiſhing flame, and in ſuffocating breathing animals; and yet what is ſingular, when combined with water, they not only are innocent, but even medicinal.

As Cheltenham Water ſeems to derive its exhilarating quality from its aërial impregnation, curioſity prompted me to make the following trial of its effects on vegetation.

Exp. 25. Two plants of ſpear-mint were placed with their roots and ſtems in two ſeparate bottles; one of the bottles containing Cheltenham water freſh drawn; the other, common pump water. The plant in the Cheltenham water, within two days drooped and withered, while the other, in pump water, remained in a healthy flouriſhing ſtate.

Hence, though this impregnation be *ſalutary* to the *human* conſtitution, it appears to be very *unfriendly* to the principle of *vegetation.*

Exp. 26. Having drank the Cheltenham water regularly, during the ſpace of three weeks, (except a day or two that its uſe was purpoſely ſuſpended) and having attentively obſerved its effects on myſelf, and others who drank it under my direction, it was generally found at the beginning to produce a ſlight giddineſs, attended with drowſineſs, ſometimes head-ach, preſently after it was taken; but theſe ſymptoms ſoon vaniſhed, eſpecially after walking a while in the open air.

As a cathartic, it operated in a very ſpeedy, gentle, and certain manner, without occaſioning gripes, faintneſs, or depreſſion of ſpirits; ſo often complained of from the operation of common cathartics, particularly of the active or reſinous kind.

It moreover promoted appetite and digeſtion, and manifeſtly increaſed the fluid ſecretions of urine and perſpiration; the balance inclining ſometimes to the former, at others to the latter, according to the ſtate of the body, the degree of exerciſe, and other circumſtances; when the weather was warm,

it

it paſſed off more freely by perſpiration; when cool, by urine.

Diſeaſes, wherein found beneficial—or apparently indicated by Analogy.

From the foregoing account it appears, that this ſaline chalybeate water is cathartic, diuretic, and ſometimes diaphoretic, and that it operates by a very gentle ſtimulus, without evidently accelerating the circulation, or irritating the nervous ſyſtem, like the rougher purgatives.

The operation of the water may be explained from conſidering the properties of the ſaline ingredients combined with a large portion of aqueous menſtruum, actuated by aërial fluids, and conſtituting a medicated compound, mild, yet active; calculated at once, to clear the firſt paſſages, to purify the chyle and lymph, and finally to cleanſe the whole glandular ſyſtem.

Though rather unpleaſant to the palate, yet it is friendly to the ſtomach, and congenial to the conſtitution. Uniting with the bile, and alimentary fluids, in its paſſage through the inteſtines, it powerfully excites the innumerable glands, diſperſed over their whole internal ſurface, to a copious diſcharge of their contents. By which it not only deterges the canals, through which it immediately paſſes, but alſo thoſe of the liver, ſpleen, pancreas, and other neighbouring viſcera, and thence is enabled to remove obſtructions, and diſburthen the glands in more remote parts. For whenever any particular gland is obſtructed, or its functions impaired by a morbid determination of impure lymph, the only rational method of relieving ſuch gland, is to produce an increaſed diſcharge, either from ſome other gland of the ſame claſs, or from thoſe of the inteſtinal tube, the *grand* emunctory from which, as from a common ſhore, the recrements of the food, and ſundry other impurities are happily evacuated: by which means the obſtructed gland is gradually cleared, and rendered permeable; and the morbid determination being altered, the weakened veſſels gain time to recover their wonted tone, and elaſticity.

Hence this water may be uſed as a powerful *evacuant*, or a gentle *alterative*, according to the ſtate of the conſtitution, and the intention of the phyſician. If the intention be to produce a copious evacuation, it is to be adminiſtered in large quantities, and at ſhort intervals. If the conſtitution will not admit of its uſe as a briſk evacuant, the intention is to be anſwered by a ſlower method, viz. that of an alterative; in order to determine it in ſmall quantities, and at longer intervals, to paſs into the blood, and to accompany all the fluid ſecretions, without ſenſibly increaſing any of them. The *purgative* plan is beſt adapted to firm athletic conſtitutions; the *alterative*, to the delicate and relaxed. In both theſe ways, have waters of this claſs been found beneficial; and in the latter, not leſs perhaps than in the former, as appears from the obſervations of our beſt writers.

" It is obvious (ſays the learned Dr. JOHNSTONE) " this water contains ſaline ingredients poſſeſſing " different attractive powers, which though ba- " lanced in the water, yet when mixed with animal " fluids and ſalts, in the courſe of digeſtion, and " circulation with the blood, muſt be ſo changed " as to form new combinations, whence compounds " poſſeſſing properties different from what exiſted " before will be produced, and the ſyſtem itſelf " is changed.

" By the ſolution of ſalts, *cold* is generated; by " their uniting into new compounds, *heat* is pro- " duced. Hence new ſtimuli, with other altera- " tions, take place in the glands and remoter " veſſels of our ſyſtem; and it is by theſe means, " as well as *evacuation*, that theſe waters become "beneficial, and are really *valuable* ALTERATIVE "medicines."*

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* See Dr. JOHNSTONE's ingenious Tract on the Walton Water (near Tewkeſbury) lately diſcovered—and which, by analyſis, he finds *extremely* ſimilar to Cheltenham water.

Certain writers ſeverely reprobate the term *alterative* as vague and indeterminate, and therefore wiſh to baniſh it from medical language; to which I ſee no mighty objection, provided a more fit term can be found, and at the ſame time more expreſſive of the effects of that claſs of medicines, which are acknowledged to produce remarkable effects, without occaſioning any ſenſible evacuation. Such are not only minute doſes of mercurials, and antimonials, but of other ſaline ſubſtances, to which I have ventured to add ſaline mineral waters, all which evidently conſtitute *chemical ſtimuli*, whoſe *modus operandi* (whatever ſome may aſſert) remains altogether unknown.

Vain, therefore, has been found every attempt hitherto made, either to explain the action of chemical ſtimuli, on mechanical principles, or to deduce the ſpecific effects of ſaline medicines from the figure or ſpiculated form of their cryſtals.

Of thoſe ſalts which exhibit ſharp-pointed *ſpiculæ*, how extremely different their operation, and effects! Compare but Epſom ſalt with corroſive ſublimate; ſal ammoniac, or nitre, with ſugar of lead, or alum; all which preſent ſharp points, or *ſpiculæ*, yet what ſimilitude can be found in their operation?—what analogy in their effects?—Though convinced of the impoſſibility of explaining their action *mechanically*, I ſuſpect this might nevertheleſs be accompliſhed on the known principles of *chemiſtry*. That this is not entirely impracticable, appears from the paſſage already cited from the ingenious Dr. JOHNSTONE. —Without however attempting any conjecture about the *cauſe* of their myſterious operation, I ſhall content myſelf with obſerving their *effects*. And till their *modus operandi* is better underſtood, ſhall ſtill take the liberty to call them *alteratives*. For I cannot help retaining, with Dr. JOHNSTONE and other reſpectable writers, a ſecret *partiality* for that *good old* term.

The diſeaſes in which this water has been found beneficial, or wherein it ſeems evidently indicated, are chiefly, if not entirely of the chronic kind, and may be conſidered under the three following heads: viz.

1. Thoſe which principally affect the organs of digeſtion.

2. Thoſe of the inteſtines, and other abdominal viſcera.

3. Thoſe of the lymphatic ſyſtem, particularly the glands.

DISEASES.

I. Of the Stomach, whether ariſing from *indigeſtion*—*repletion*—or *ſpaſm*, as - - - - -	SICKNESS VOMITING ACIDITY PAIN, &c.
II. Of the Bowels, and other abdominal viſcera, whether from *redundancy*, *acrimony* of their contents, *ſpaſm*—or *obſtruction*, as - - - -	HYPOCHONDRIAC AFFECTION COLIC, or SPASMODIC PAINS JAUNDICE GALL-STONES GRAVEL TYMPANY COSTIVENESS PILES, &c.

III. Of the Lymphatic Glands—or Cutaneous Ducts, ariſing from *depravity* of the *Lymph*—*infection*—or *inactivity*, as

- RICKETS
- SCHIRRUS
- SCROPHULA
- TUBERCLES OF THE LUNGS?*
- OPHTHALMIA
- SCALD HEAD
- LEPROSY
- LUES VENEREA?*
- ULCERS
- ERUPTIONS, &c.

The above claſſes comprehend a great variety of chronic diſeaſes, in which reaſon, experience, and analogy, ſeem to unite in bearing teſtimony to the propriety, and utility of this water. But its ſucceſs will, I conceive, greatly depend on its being taken at an early period, and duly managed, particularly in caſes of the more *ſtubborn* kind.

Caſes wherein ſuppoſed doubtful—or even improper—Conſequences of its abuſe.

It is proper to obſerve, that many of the abovementioned diſeaſes are often complicated with others that require different treatment, and which conſequently muſt render the uſe of this water ſometimes doubtful, at others totally repugnant to the principal intention of cure. Such in general are all nervous diſeaſes, which rarely bear the repetition of cold purging ſalts with impunity.

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* Here the Notes of Interrogation imply further Inquiry.

Dr. Smith indeed mentions *one* inſtance of a ſpecies of palſy, wherein the Cheltenham water proved ſucceſsful; but this affords but *one* exception to the general rule.* If through *peculiar* circumſtances other inſtances ſhould occur, it will be neceſſary to diſcriminate *ſuch* circumſtances accurately, before any inference can be drawn, either as to the *general*, or *partial* uſe of theſe waters in *nervous* diſeaſes.

Another very important queſtion ariſes—How far may theſe waters be uſed with ſafety, and a proſpect of ſucceſs, in incipient *tubercles* of the lungs, which if neglected at the beginning, too often terminate in conſumption? This may deſerve the attentive obſervation of the diſcerning part of the faculty, who alone are competent to the taſk of diſtinguiſhing tubercles in their *naſcent* ſtate, or of obviating the progreſs of that inſidious malady, ſo often fatal to the youthful inhabitants of this iſland. The ill ſucceſs that has hitherto attended the ſeveral remedies extolled under the pompous terms of *vulneraries*, *pectorals*, and *balſamics*, tacitly admoniſhes us to adopt other methods of treatment, and to form our indications of cure on more rational principles.

A mineral water which poſſeſſes the power of pervading the lymphatic ſyſtem, and of diſburthening obſtructed glands in remote parts of the machine, by promoting an increaſed ſecretion from the inteſtinal glands, and that without heating, or weakening the frame, ſeems, of all others, the moſt likely to anſwer the intention. Now the Cheltenham water not only poſſeſſes theſe properties in an eminent degree, but has *actually* been found ſucceſsful in diſcuſſing glandular tumours in other parts of the ſyſtem, and therefore has every argument in its favour that analogy can ſuggeſt.

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* Obſervations on the Uſe and Abuſe of Cheltenham Water.

The ſmall portion of iron contained in the water need not be dreaded on account of its ſuppoſed *heating* quality, which is effectually obviated by a large proportion of cooling ſalts ſufficiently diluted; and be it remembered, that the objection lies much ſtronger againſt the reſinous *gums*, *balſams*, *Peruvian bark*, *ſquills*, and other *ſtimulants*, which often ſerve but to exaſperate the ſymptoms, and yet continue to be daily exhibited in this diſeaſe, without fear or apprehenſion.

Where confirmed tubercles of the lungs have already advanced to ſuppuration, the caſe is become too deſperate to admit of any permanent relief, from this, or perhaps any other remedy hitherto diſcovered. This water therefore is propoſed not to *cure ulcerated* lungs, but to *prevent* the lungs from *ulcerating*;

ulcerating; not to *diſperſe inveterate* tubercles, but to *crop* them in the early bud.

To particularize the various circumſtances, wherein the uſe of this water may be doubtful or improper; or to enumerate the ſymptoms which might ſeem to contra-indicate its operation, compared with that of other ſaline purgatives, would far exceed my preſent bounds.

It may be ſufficient to obſerve in general, that wherever the nervous ſyſtem has been much weakened, the vital powers greatly diminiſhed, or the ſtrength impaired by natural, or artificial diſcharges, or other debilitating cauſes; or finally, where evacuants depreſs the ſpirits, or irritate the nerves; it ought by no means to be adminiſtered as a *direct* purgative, nor even as an *alterative*, without the utmoſt circumſpection. Neither ought the purgative courſe, in any caſe, to be continued for ſeveral weeks ſucceſſively without ſome intermiſſion. Much leſs ſhould this water be ever wantonly drank, or unneceſſarily, eſpecially by healthy perſons, (as certain ignorant ruſtics are wont to do without meaſure, or bounds) as if profuſe purgation was a matter of indifference, or rather neceſſary to improve good health—a dangerous deluſion!—The habitual uſe of purgatives, even of the milder ſort, not only impoveriſhes the habit, but undermines all the powers of life; and finally, too often uſhers in a long and diſmal train of hypochondriacal or nervous ſymptoms!

Nor are inſtances wanting, as I have been informed, where impaired viſion, or even a *Gutta Serena*, with other nervous ſymptoms of an alarming nature, have been certainly produced by ſuch an improper *uſe*, or rather prepoſterous *abuſe* of theſe waters!

Directions for drinking it with ſucceſs.

The moſt ſuitable ſeaſon for a courſe of the Cheltenham water, is undoubtedly during the ſummer months, namely, from the middle of May, till the latter end of September. In caſes of exigency, it may be uſed at other times, though ſeldom perhaps with equal advantage.

With regard to preparatory means, internal medicines are ſeldom neceſſary; the water itſelf ſupplies its own proper *preparative*, and, if diſcreetly managed, ſuperſedes the uſe of other evacuants. *Warm bathing*, indeed is often requiſite previous to its uſe, in certain ſtubborn diſeaſes of the glands, and particularly where they are attended with obſtructed perſpiration, rigidity of the fibres, ſpaſmodic ſtrictures, cutaneous affections, &c.

In theſe, and various other inſtances of this kind, the celebrated Warm Springs at Bath very *juſtly* bear the *pre-eminence*, and ought therefore to precede that of Cheltenham, or rather *ſupply* its place. The Bath waters are, moreover, much better provided with every neceſſary convenience for *general* or *partial* application. The Cheltenham water, in its turn, preſents us with a very uſeful preparative for a courſe of the Bath waters, particularly in caſes where ſaline purgatives *only* are required.

Early riſing being conducive to health in general, and to the ſucceſsful uſe of this water in particular, the invalids ought to repair to the ſpring at an early hour, and drink the water freſh at the fountain head, the inſtant it is poured into the glaſs, leſt the aërial principles ſhould exhale.

Admitting the importance of theſe ſubtile fluids, we may account for the material difference experienced between drinking the water freſh at the pump, and after it has ſtood expoſed to the air, or been conveyed to a diſtance. For though it retains its purgative ingredients after the volatile parts have eſcaped, yet the exhilarating quality is loſt; an entire decompoſition takes place, and it no longer produces the ſame effects as when it is drank freſh, and replete with thoſe active principles. Hence, we perceive the error of thoſe patients, who, through indolence or inattention, content themſelves with having the water brought to their lodgings in bottles, often very imperfectly corked:—A cuſtom too prevalent, eſpecially among people of faſhion, who thus loſe the main efficacy of the water, together with that exerciſe in the open air which is ſo highly conducive to its ſucceſs!

When patients are accidentally detained at their lodgings through the inclemency of the weather, the water ſhould be brought in a bottle with the cork downwards, and remain in that poſition till the moment it is uſed.

At the beginning of the courſe, it may be prudent, at leaſt the two firſt days, to commence with the ſmalleſt ſized glaſs, viz. a quarter of a pint at firſt riſing in the morning, as a gentle laxative. If it produces no ſenſible effect within three hours, it then may be repeated. If this quantity fails of producing two eaſy motions, it may be increaſed the next day to half a pint.

Some drink with eaſe two or three glaſſes before breakfaſt; others cannot bear half this quantity without ſuffering great inconvenience from the coldneſs, and preſſure of the water. In ſuch caſes, it will be much better to take ſmall doſes, at longer intervals: For inſtance, the firſt glaſs before breakfaſt; the ſecond an hour after breakfaſt; and the third about eleven o'clock, walking or riding between each glaſs. Thus the whole may be conveveniently over before noon, and yet admit of a pleaſant airing in the country before dinner.

After the firſt week, the quantity may be increaſed to half a pint or upwards, three or four times a day, according to its operation, and the intention of the preſcriber. When it paſſes off too ſlowly, a glaſs may be taken in the evening, or a quarter of an ounce of the neutral ſalt may be diſſolved in a half pint glaſs of the water for the morning doſe; drinking immediately after it a baſon of warm tea or gruel, eſpecially if the water occaſion a ſenſe of chillneſs, or flatulency in the ſtomach or bowels.

Some, with a view to obviate theſe inconveniences, heat the water over the fire, which, by diſſipating its volatile parts, greatly diminiſhes its virtues, and inſtead of making it more palatable,

table, as Dr. RUTTY aſſerts, renders it abundantly more nauſeous.

Others, with a ſimilar intention, have recourſe to tinctures, eſſences, or ſundry aromatic ſeeds in form of comfits, or ſugar-plumbs; when a glaſs of ſimple pepper-mint water, or even briſk exerciſe alone, would anſwer the intention much better, and that without perverting the operation of the water, palling the appetite, or injuring the digeſtive powers, which an habitual uſe of ſuch remedies is extremely apt to do.

A courſe of this water may require from three to five weeks, or upwards, but not without ſuſpending its uſe one day in each week, in order to give the ſyſtem proper reſpite, and to prevent the water loſing part of its efficacy through habit;* finally, it ought to be left off in the ſame gradual manner in which it was begun, uſing, for the ſpace of two or three weeks after it, a more abſtemious diet, and guarding againſt coſtiveneſs.

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[*] Therefore His MAJESTY's Royal Command for ſhutting up the fountain on Sundays, whether conſidered in a *religious* or *medical* point of view, appears to be ſtrictly proper; it is moreover founded on ſound policy, being well calculated to accommodate the company with a plentiful ſupply of the water the enſuing week.

The propriety of the above caution will appear obvious, when it is conſidered, that large evacuations long purſued, and then ſuddenly diſcontinued, diſpoſe the ſyſtem to plethora and all its conſequences, eſpecially if a free courſe of living be imprudently indulged.

Hence perhaps may be explained the vertigo, head-ache, drowſineſs, and other manifeſt ſymptoms of plenitude, which often ſucceed ſuch improper conduct, and which have a manifeſt tendency to defeat the main intention of the whole preceding courſe.

Diet and Regimen.

Intemperance, or inattention to diet or regimen, may entirely fruſtrate the hopes of the patient and of the practitioner, in regard to the utility of this as well as other waters. Such are the immoderate uſe of groſs animal food, the abuſe of ſtrong liquors, indolence, late hours, hot rooms, and ſudden expoſure to cold, particularly in the night ſeaſon, or the drinking cold liquors after the body is heated by dancing, or other violent exerciſe.

The food, on the contrary, ought to be moderate in quantity, ſimple, eaſy of digeſtion, and nutritious. It ſhould alſo be accompanied with a due proportion of farinaceous aliment, and eſculent vegetables, many of which the ſoil of this country produces in great abundance, and in very high perfection.

For breakfaſt, cocoa or chocolate, with milk, and other light ſpoon-meats, are in general preferable to either tea or coffee.

At dinner, broths or ſoups, together with any ſort of animal food or freſh fiſh that beſt agrees, may be eaten with moderation.—The drink may conſiſt of good table beer, followed by a few glaſſes of generous wine.

Summer fruits, either before or after meals, are by no means objectionable, provided they are perfectly ripe, and eaten ſparingly.

The exerciſe ſhould conſiſt chiefly of riding or walking, and ſhould be uſed before meals, and regularly purſued during the whole courſe.

It is almoſt ſuperfluous to add, that not only every kind of exceſs ought to be carefully avoided, but alſo intenſe ſtudy and application; for above all things, the mind ought to be kept tranquil, or agreeably amuſed.* All unneceſſary concern about buſineſs, or domeſtic affairs, muſt for a while be diſmiſſed, and every cauſe of grief, anxiety, or inquietude, if poſſible, prevented:—A circumſtance of the utmoſt importance to all perſons labouring under inveterate diſeaſes, who wiſh to reap real benefit from this, or indeed any other courſe of medicine.

Having thus attempted briefly to point out the general principles of the Cheltenham water, the diſeaſes in which it is indicated, and the directions neceſſary to its uſe, I forbear deſcending to other particulars. The nature of the water being once underſtood, theſe will readily ſuggeſt themſelves to the intelligent reader.

As no invariable rule in matters of this ſort can be laid down, the diſcreet practitioner will vary the plan according to the operation of the water, the ſtate of the diſeaſe, the conſtitution of the patient, and other circumſtances.

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* Reſpecting the Public Amuſements, New Improvements, Natural Curioſities, Agreeable Rides, Extenſive Proſpects, appertaining to the place; ſee the new edition of A TOUR TO CHELTENHAM SPA, by SIMEON MOREAU, Eſq; M. C. where the reader's curioſity will be abundantly gratified concerning all theſe particulars.

From due attention to the above cautions, he will alſo be enabled to determine whether the water ought to be uſed as a direct *purgative*, or only as an *alterative*; and finally, to provide for unſeen accidents that may happen during the whole courſe.

TO CONCLUDE:—Since the nature and qualities of mineral waters can only be aſcertained by a ſeries of experiments and obſervations, inſtituted on the ſpot, it were earneſtly to be wiſhed, that a NEW AND ACCURATE ANALYSIS OF SEA-WATER, and alſo OF OUR PRINCIPAL MINERAL SPRINGS, were undertaken BY AUTHORITY, as a matter of PUBLIC CONCERN; and that the Royal College of Phyſicians would adopt ſuch meaſures, as to them might ſeem neceſſary, for carrying it into execution.

That, in the interim, the reſident practitioners were requeſted to expedite the work, by preſerving accurate journals of the principal caſes committed to their care, candidly noting down the UNSUCCESSFUL, as well as the ſucceſsful events. The reſult of ſuch an inquiry, impartially conducted, would redound much to their honour, and afford the public more ſatisfactory information concerning mineral waters, than they have ever yet been favoured with.

It would alſo reſcue our medicinal ſprings from the opprobrium of being frequented, as they now commonly are—on no better foundation, than that of faſhion or caprice.

Some it would bring into notice, that are now but obſcurely known; others it would ſtrip of their borrowed plumes, by proving their inefficacy, and by expoſing the fabulous cures attributed to them by ignorance, ſelf-intereſt, or ſuperſtition. Each would thus, in time, find its own proper level in the ſcale of merit. Their natural and chemical hiſtory would be completed;—their comparative virtues aſcertained;—ſcience enlightened;—and the practice of medicine improved.

Our medical practitioners would then no longer be at a loſs concerning the nature and properties of the different mineral waters. Inſtead of placing, as heretofore, implicit confidence in the peremptory aſſertions of preceding writers, they would then be qualified to detect their errors—Inſtead of yielding, as at preſent, to the overwhelming influence of popular prejudice, they would then be enabled to aſſert their *own* judgment—Inſtead of heſitating in their choice concerning *this* or *that* ſpring, or recommending waters of oppoſite qualities indiſcriminately, they would then, in the firſt inſtance, be competent to decide with propriety.

In a word—inſtead of diſpatching their patients, as at preſent, in the random purſuit of *imaginary* virtues, they would then be enabled, at once, to direct them with preciſion to ſuch as were *real.*

APPENDIX.

WATER—*Whether it be not eſſential to Air—and whether its component Parts be yet diſcovered.*

SINCE the preceding ſheets were ſent to the preſs, I find that, in conſequence of ſome recent experiments, the ingenious Dr. PRIESTLEY is *now* convinced that *water* not only enters into the compoſition of *inflammable* air, but alſo into that of *vital* and *fixed* air, and is therefore probably the *baſis* of every ſpecies of air.

He moreover delivers it as his opinion, that the exiſtence of phlogiſton, though doubted by ſome, yet remains firm and unſhaken.—That *this* principle with *water* conſtitutes *inflammable* air, while a *peculiar acid* with *water* forms *vital* air.—That *this* acid of vital air (whatever it may be) is the baſis of all other acids, and may be conſidered as the principle of *acidity*, while the *phlogiſton* conſtitutes the *alkaline* quality of bodies.—But that no *aëriform* fluid can exiſt without *water*, which he finds eſſential to their compoſition.

If *air* then cannot be wholly diveſted of *water*, nor *water* of *air*, does it not follow, that water cannot be cómpletely decompoſed? and conſequently that the late BRILLIANT DISCOVERY of water being compoſed of equal parts of inflammable and vital air (received with ſuch univerſal avidity) muſt at laſt, though not without regret, be given up!

CHELTENHAM WATER—*How far it may be imitated by Art—Attempt towards an Artificial Cheltenham-Water.*

At a diſtance from the Spa, and where the natural water cannot be procured in its freſh and genuine ſtate, the following *humble* imitation may probably prove not wholly unacceptable. It is not pretended *exactly* to reſemble the former in taſte and appearance, much leſs to ſuperſede the neceſſity of drinking the *genuine* water at the *fountain-head*, whenever that can be complied with. Should it only be found, in ſome meaſure, to approach the real Cheltenham water, in its general operation and effects, it may be perhaps deemed no contemptible ſubſtitute in caſes of emergency; which is all that is propoſed, or indeed can be reaſonably expected. As *ſuch* then, where a ſaline chalybeate water is immediately wanted for extemporaneous uſe, I ſhould incline to recommend the following form, which is eaſily prepared by any apothecary poſſeſſed of the glaſs apparatus for impregnating water with fixed air.*

	Grains.
Take pure Glauber and Epſom ſalts, of each	120
——— of common ſalt — —	6
——— magneſia-alba — —	3
——— flowers of ſulphur — —	8
——— clean iron filings — —	5
——— Spring water previouſly boiled, or rather diſtilled——2 quarts.	

Having put theſe ſeveral ingredients into the middle veſſel of the above-mentioned apparatus, let the whole be impregnated with fixed air diſcharged from an effervеſcent mixture, compoſed of vitriolic acid with powdered chalk, or rather marble, according to the printed directions for preparing Pyrmont water.

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* This elegant apparatus, invented by Dr. Nooth, has been conſiderably improved by Mr. Parker, in Fleet-ſtreet, London; and may be had at all the principal glaſs-warehouſes, with printed directions.

The proceſs may be expedited by agitating the veſſel occaſionally, and may be eaſily completed in two hours; when the water may be drawn off and paſſed through flannel, or a common ſtrainer, into clean pint bottles; it will then be fit for uſe, and may be drank according to the directions already given concerning the real Cheltenham water.

The ſulphur, if previouſly ground with *calcined* magneſia, will more readily yield the ſulphureous impregnation; but if this quality ſhould be required in a ſtronger degree, or equal to that of Harrowgate *water*, it may be readily accompliſhed, by only putting about a dram of *hepar ſulphuris* (prepared from ſulphur and quick lime in equal proportion) into the bottom veſſel, along with the efferveſcing ingredients.

The phlogiſticated air will be alſo thus in ſome meaſure ſupplied, and, if thought neceſſary, may be increaſed to any pitch, by agitating the water with common air in which a lighted match or candle has burnt out.

The ſelenite, being conſidered as wholly immaterial, is purpoſely omitted for reaſons already aſſigned.[*]

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[*] Exp. Inq. p. 80.

The Mephitic Alkaline Water.

This remedy was firſt introduced to our notice by that expert chemiſt the late Mr. Bewley, under the term Mephitic Julep. Having diſcovered fixed air to be an *acid* capable of neutralizing alkaline ſalts, he juſtly concluded that, by this union, water might be more ſtrongly impregnated with this ſubtile acid than by any other means, and therefore propoſed it to the faculty, as a compendious method of adminiſtring fixed air very copiouſly as an antiſeptic remedy:—An object highly worthy our conſideration in all putrid diſeaſes; and yet, by ſome ſtrange fatality, it has been almoſt wholly neglected!

To Mr. Benjamin Colborne it is owing, that our attention has lately been recalled to this elegant form of medicine, though with a very different intention.——To him we are indebted for the important diſcovery of its efficacy in thoſe excruciating diſeaſes—the ſtone and gravel. After long undergoing himſelf the ſevereſt tortures, without any proſpect of relief from other remedies, he firſt experienced its happy effects in his own perſon, and afterwards recommended it to many of his fellow-ſufferers, and with the like ſucceſs. Since which, its reputation has very rapidly advanced, and it now may perhaps be conſidered as one of the ſafeſt and moſt efficacious medicines hitherto diſcovered.

It comes, moreover, with this peculiar recommendation in its favour, that it is not, through motives of intereſt or pecuniary advantage, brought forward under the myſterious guiſe of a ſecret *noſtrum*; but the remedy is at once candidly divulged, and every circumſtance laid open, together with the names and places of abode of many reſpectable characters, who have tried it with the happieſt effect.

Method of preparing it.

As it is a matter ſo extremely *intereſting* to the cauſe of humanity, it cannot be made too public; I ſhall therefore here ſubjoin the rules neceſſary to be obſerved in preparing it. As this, however, has been already done with great accuracy by the learned Dr. Falconer, I ſhall adopt his words, as they ſtand in the printed narrative.*

“ The moſt convenient method (ſays he) of pre-
“ paring the alkaline ſolution, is as follows. Put

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* See his Appendix to Dr. Dobson's Commentary on Fixed Air, new edition, p. 8.

"two ounces and a half troy weight, or, if troy "weights are not at hand, two ounces and three "quarters avoirdupois,† of dry ſalt of tartar into an "open earthen veſſel, and pour thereon five full "quarts, wine meaſure, of the ſofteſt water, that is "clean and limpid, that can be procured, and ſtir "them well together with a clean piece of wood. "After ſtanding 24 hours, carefully decant, from "any indiſſoluble reſiduum that may remain, as "much as will fill the middle part of one of the "glaſs machines for impregnating water with "fixible air.‡ The alkaline liquor is then to be "expoſed to a ſtream of air, according to the direc-"tions commonly given for impregnating water§ "with that fluid. When the alkaline ſolution has "remained in this ſituation till the fixible air ceaſes

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"† Two ounces and a half troy weight contain 1200 grains; "two ounces and three quarters avoirdupois contain 1201 grains "and a quarter of a grain.

"‡ If the ſalt of tartar be good, and perfectly ſoluble in the "water, every ounce meaſure of the alkaline ſolution ſhould con-"tain ſeven grains and a half of alkaline ſalt.

"§ Thoſe machines that have a contrivance for drawing off "the water without ſeparating the parts of the veſſel are moſt "convenient. The directions given with the machines ſold by "Mr. Parker in Fleet-ſtreet, will ſerve this purpoſe very well, "ſave that the alkaline ſolution requires more of the efferveſcing "materials, and a longer time to ſaturate it, than ſimple water.

" to riſe, a freſh quantity of the fermenting materials ſhould be put into the lower part of the " machine, and the ſolution expoſed to a ſecond " ſtream of air, and this proceſs repeated four times.

" When the alkaline liquor ſhall have continued " about 48 hours in this ſituation, it will be fit for " uſe, and ſhould then be carefully drawn off into " perfectly clean bottles (pints are, I think, preferable) and cloſely corked up. The bottles ſhould " then be placed with their bottoms upwards* in a " cool place; and with theſe precautions it will " keep ſeveral weeks, and perhaps much longer, " very good.

" The quantity of alkaline ſolution above directed to be mixed at the beginning of the foregoing directions, is judged to be ſufficient to fill " the glaſs machines of the common ſize twice " over, without pouring off the liquor ſo deep as " to hazard making the ſolution turbid, by ſtirring " up the indiſſoluble reſiduum which is precipitated " at the bottom of the veſſel.†

" * A ſhelf with holes in it to put the necks of the bottles " into, ſuch as are commonly uſed for wine decanters, is convenient for this purpoſe.

" † If the alkaline ſolution, as above directed, ſhould be found " too irritating, it may be made with a ſmaller proportion of

" The water in which the alkali is diſſolved, " ſhould be as free of foreign impregnations as poſ- " ſible, as the alkali, by decompoſing them, will " not only cloud the water, but form other combi- " nations, inconſiſtent, perhaps, with the effects to " be wiſhed for from the remedy. The intention " therefore of mixing the ſalt of tartar with the " water the day before, and of the caution recom- " mended in pouring it off, is to allow time for any " precipitation occaſioned by the mixture to ſettle, " as well as to ſeparate the indiſſoluble parts of the " ſalt of tartar itſelf.

" Nor is leſs attention neceſſary in procuring the " ſalt of tartar pure and in perfection; and on that " account it ſhould be got from ſuch places only as " can be depended upon. When properly pre- " pared, the alkaline mephitic water ſhould be " perfectly clear and rather ſparkling, of an acidu- " lous taſte, and totally free of that diſagreeable " impreſſion which alkaline ſalts make on the " tongue and throat.

" About eight ounces by meaſure appear, from " ſome of the caſes, to have been taken thrice in " twenty-four hours, for a conſiderable time toge- " ther, and to have agreed well with the ſtomach, " appetite, and general health; but I apprehend

" moſt people will think this too large a quantity;
" and I believe, that for moſt caſes, two-thirds
" of a pint of the alkaline liquor in 24 hours may
" ſuffice. Should the bulk of the ſeparate doſes*
" be thought too large, the alkaline ſolution may
" be made of double the ſtrength; in which caſe,
" half the quantity will be enough.

" The times of taking three doſes in the day
" have been, I believe, pretty early in the morning,
" about noon, and about ſix in the evening. If
" twice a day, about noon and in the evening; and
" if once, which in many caſes ſeems ſufficient for
" a preventative, about an hour and a half before
" dinner. Common prudence dictates, that ſuch
" a remedy ſhould be taken at ſuch times as the
" ſtomach is leaſt likely to be loaded with victuals.

" I do not find, from obſervation or inquiry, that
" a rigid adherence to any particular regimen of
" diet is neceſſary, farther than the uſual pruden-
" tial cautions of moderation and temperance.

" The Reverend Dr. Cooper has made uſe of
" fruit, wine, and other things ſubject to aceſcency,
" during the time of his taking the ſolution; yet
" no perſon, as will appear by his very judicious

" * See Dr. Cooper's Caſe.

"account, has received greater benefit. I however "think it would be adviſeable to abſtain from "acids, and from ſuch things as are ſubject to "become aceſcent, for ſome time before, and alſo "after the time of taking the doſes of the alka"line ſolution.

"I do not find either from my own obſervation, "or from the accounts of others, that any very "perceivable effects, ſave that moſt to be wiſhed, "the abatement of the troubleſome ſymptoms, "followed the taking this remedy. I have in"quired of a very ſenſible perſon of this city, who "has taken the ſolution in the largeſt quantity of "any that I have known; and he aſſures me, that "he found no effect from it, ſave that of gently "opening the body.

"Mr. Bewly ſpeaks of a doſe of it that he took "affecting the head (with vertigo I ſuppoſe) and "proving a pretty ſtrong diuretic. But no ſuch "conſequences have been generally obſerved by "thoſe perſons of whom I have had an opportu"nity of inquiring. The perſon before referred "to, informed me, that though it kept the body "gently open, it had no effect in increaſing the "quantity of urine. Mr. Bewly's doſe was indeed "large, he having taken, at one doſe, ſuch a quan-

"tity of the alkaline ſolution as contained 24 "ounces by meaſure of fixible air; whereas the "quantity of air taken at a time, in a doſe of the "ſolution above directed, is not calculated to "exceed 15 ounces; but this was repeated three "times a day, and no ſuch effect obſerved. With "reſpect to the diuretic quality, it is well known "that the expectation of ſuch an effect from any "thing we take, will often prove a very powerful "means of producing it.

"Should it prove cold or flatulent to the ſto-"mach, as I have myſelf known it to do, though "I believe that rarely happens, a ſmall portion of "ſpirits, as rum or brandy,* or any of the ſpiri-"tuous waters or tinctures, may be uſed without "any diminution of its good effects. A tea ſpoon-"ful of rum is mentioned to be taken with each "doſe of the ſolution, in one of the caſes ſubjoined, "and I have myſelf directed a ſmall quantity of "tincture of cardamoms and of compound ſpirit "of lavender, with evident advantage. Mr. Col-"borne has found hot milk, in the proportion of "about one-fourth to that of the alkaline ſolution, "to be a very grateful addition, eſpecially in cold "weather, and what tended much to reconcile it "to the ſtomach, and this without impairing in "the leaſt its good qualities."

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* See Dr. Cooper's Caſe.

The alkaline ſolution might be yet more ſtrongly impregnated with fixed air, and its virtues perhaps proportionably increaſed, were the water made uſe of previouſly diveſted of its atmoſpheric air, either by boiling or diſtillation. Might not this therefore be ſuggeſted as a material improvement in the proceſs?

As to its general operation, it is ſaid to act as a mild laxative, without exerting any evident diuretic power. Here, however, I muſt obſerve, that in every caſe, in which I have yet tried it, it *conſtantly* and *uniformly* diſcovered *diuretic* effects; and water impregnated with fixed air *alone*, is known to act as a diuretic, and remarkably ſo when combined with ſalt of tartar even in its ſimple ſtate.

The mephitic water is not only found more efficacious than fixed air alone, but alſo poſſeſſes the ſingular property of preventing the urine of gravelliſh ſubjects from depoſiting any ſand or earthy ſediment, and at the ſame time corrects the acrimony of the urine, and thereby aſſuages pain, and obviates the return of paroxyſm.

The alkali in this preparation being neutralized by the aërial acid, and therefore rendered perfectly mild and innocent, is doubtleſs, in point of ſafety, infinitely ſuperior to the cauſtic alkaline ley, and perhaps not inferior as a ſolvent. The copious earthy ſediment which the urine depoſits during a courſe of the ſoap ley, and which is triumphantly held forth by its advocates as an indubitable proof of its *ſolvent* power, is, I conceive, a mere deception. For this ſediment, inſtead of demonſtrating its action on the ſtone itſelf, only proves that, as a cauſtic, it abrades the veſſels through which it paſſes, and as an alkali, naturally precipitates from the urine the terrene particles.

The tranſient relief from pain occaſioned by it may perhaps be explained from its overpowering, for a while, the morbid ſtimulus produced by the ſtone, and rendering the body leſs ſenſible of the irritation. Beſides, the mephitic alkaline water yields ſuperior relief, without producing the ſmalleſt appearance of earthy ſediment in the urine; but how far it may at length be found a *real ſolvent* of the ſtone in the kidnies or bladder, time only can determine.

The human calculus, acccording to the analyſis of the accurate Bergman, conſiſts of calcarious earth, intimately united with the ſaccharine acid, and a portion of fixed air, which union, agreeably to the laws of chemical attraction, cannot be diſſolved by an alkali, either mild, or cauſtic, becauſe the ſaccharine acid unfortunately prefers a calcarious earth to either of them.

How far the united force of an alkali, ſuperſaturated with fixed air, may be able to accompliſh this great *deſideratum*, by means of double elective attraction, I will not venture to decide. Thus much however is known by experiment, that tho' calcarious earth, with its *ordinary* proportion of fixed air, is inſoluble in water, yet when an *extraordinary* quantity is added, it is rendered eaſy of ſolution in an aqueous menſtruum.

Hence perhaps it is, that the preſent remedy, by ſuperadding this neceſſary proportion of fixed air, increaſes the power of the menſtruum, and thereby prevents the depoſition of earthy ſediment in the urine. But be this as it may, human calculi have been found not only eroded, but conſiderably diminiſhed in their weight, by being immerſed ſeveral hours in the mephitic ſolution;* which ſeems to demonſtrate, that this circumſtance actually takes place, at leaſt, *out* of the body.

The alkali in the mephitic water acquires double the proportion of fixed air contained in it previous

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[*] Appendix to Dr. Dobſon's Commentary on Fixed Air, p. 94, 95.

to the impregnation, and may therefore ſpare the neceſſary quantity for diſſolving the calcarious earth, and conſequently may thus be enabled to produce the effect juſt mentioned. Hence perhaps may be alſo explained the powerful effect of the Caroline waters in nephritic caſes.

As the mephitic ſolution ſo powerfully corrects the acrimony of the urine,—and has moreover, I apprehend, a powerful *ſedative* quality, it may, independently of its ſuppoſed ſolvent power, prove alſo very beneficial in mitigating the ſevere pains occaſioned by inveterate ulcers, or even cancerous affections of the urinary paſſages. And therefore, by further inquiry, may poſſibly be found applicable to the important purpoſes of alleviating human miſery in a variety of forms, and of adminiſtring eaſe and comfort, where theſe bleſſings were the leaſt expected.

THE END.

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